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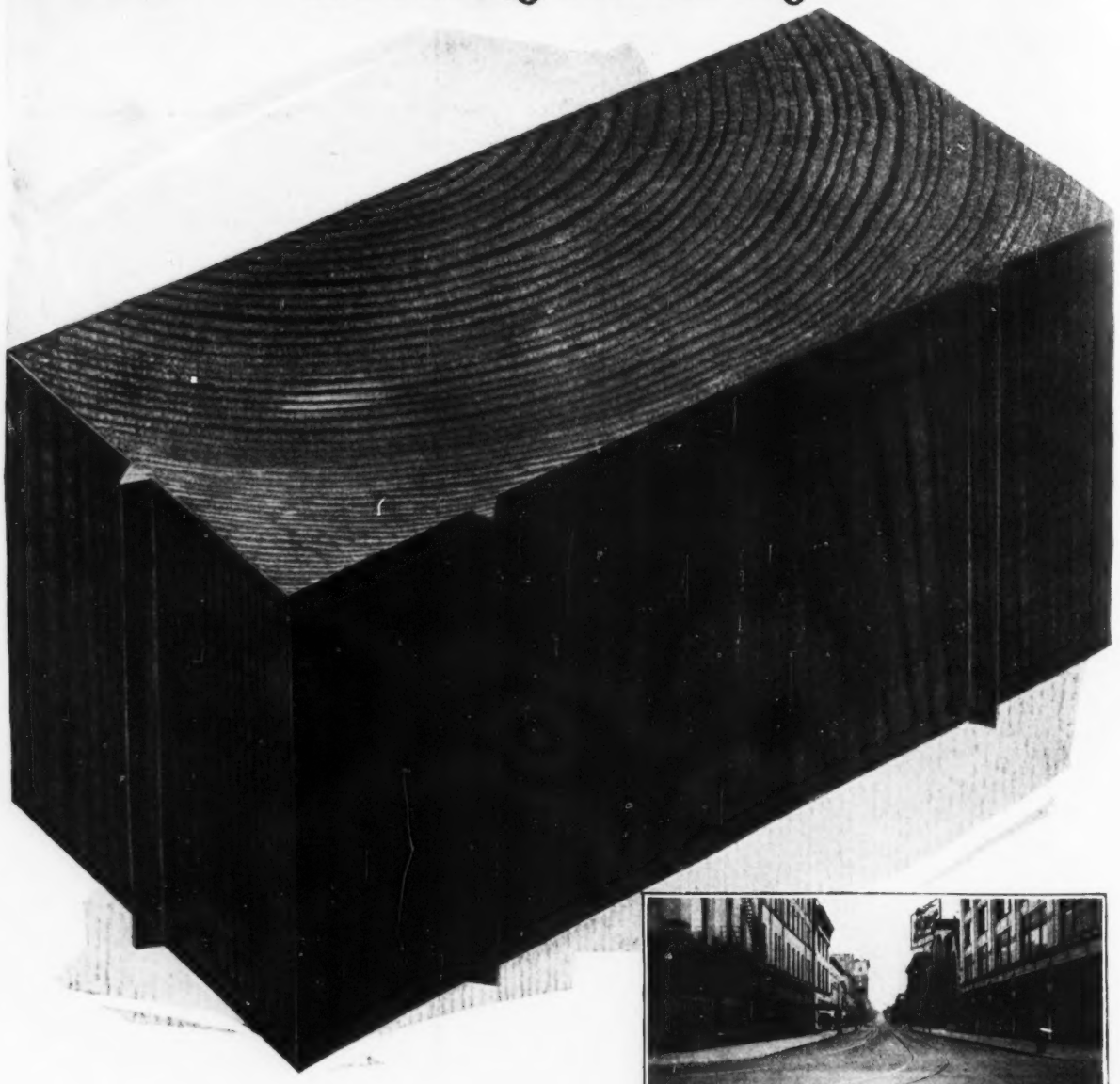

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DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

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Labor Efficiency Decrease

ASSERTIONS that labor efficiency has decreased materially of late are many and positive. Almost everyone knows or at least feels strongly that these assertions are based on experience but supporting data are scanty. Who has specific proof, based on reliable records of labor efficiency before, during and since the war?

Council Endorses Federation

AS NOTED in the news section last week, Engineering Council has endorsed the plan of organization of the Federated American Engineering Societies. This action, following closely upon the Organizing Conference last month, is timely and constructive for it removes the possibility of having two organizations working at cross purposes. Council, however, has gone further than a mere approval of the federation plan; its executive committee has been definitely instructed to co-operate with the Joint Conference Committee in effecting a permanent organization for the federated societies and to assist in any way possible the work begun at the Organizing Conference. While Engineering Council has done some excellent work, it has been felt for some time by members of the profession that it was organized on lines not calculated to produce the results desired. The demand has been insistent for some body more democratic than Council and more directly responsible to the membership of the societies which it represented. With the Federated American Engineering Societies definitely organized there will be no reason for the further existence of Engineering Council. In endorsing the federation, therefore, Council in a way sounds its own death knell, but in so doing it gives evidence of the new spirit of co-operation and solidarity which is developing throughout the profession and which will make it possible for engineers, in the future, to speak with a united voice and to insure for their message a respectful hearing.

Variety in Building Laws

IN ANY such discussion of structural requirements as that given on another page in an article on wind loads —an article, by the way, which concludes a most valuable series of analyses of building code requirements by the same author, based on many years of practical dealing with codes—the wide divergence between the provisions made by various municipal and other authorities to govern building work stands out strikingly as a puzzling fact. It is as well, in thinking of this, to bear in mind that there are such things as geographical differences, affecting not merely the intensity of wind storms, character of soil and possibility of earth disturbances, but also the current methods of engineering practice. However, making all possible allowance for these factors, and for the likelihood of strict or less strict supervision of plans by the public authorities, it is patent that the larger part of the difference between various codes is quite arbitrary, arising from the compilers' whims or lack of information. The most important service that discussions like Mr. Fleming's can do the technical community (and the public as well) is to lead toward more rational ways of dealing with natural forces and building methods, so that we may in time get somewhere near uniformity in requirements throughout the country. It is by no means certain that absolute uniformity would bring any particular benefit. Now that the Engineering Standards Committee has entered upon the course of developing safety codes, which in the end are bound to include municipal building ordinances within their scope, it seems probable that the attempt will be made some time in the future to create a single standard building code under technical auspices. Whether the formulation of such a code will result in its general adoption by municipal legislatures remains to be seen; and, as we have intimated, the argument is by no means one-sided. But it may be taken as certain that a standard code would do useful service as a model.

Lobbying of the Right Sort

CONNOTATION and usage to the contrary notwithstanding, the word "lobbyist" is not necessarily a term of reproach. On some matters legislators have to be advised and urged toward action for the public good, either to offset the evil or unwise influences which are always at work or to supply needed information. Fortunately engineers collectively are beginning to recognize the distinction between a good and a bad lobby; witness the active work in favor of the proposed Department of Public Works. In the final passage of the Federal Water-Power Bill the mass action of the profession did not come into play, but there were a few individuals who carried on a private fight. Prominent among them and practically alone as a representative of the civil engineering profession was Hugh L. Cooper. Colonel Cooper, it is well known, is interested in some large hydro-electric developments which have been awaiting the passage of the law. But in spite of this his engineering advice was repeatedly accepted by congressmen on whom it was sometimes forced, but by whom it was more often sought. For ten years his time and money have lavishly gone to the furtherance of proper power legislation, and now that, so far as Congress is concerned, the issue is successfully terminated proper credit should be given him by those, engineers and public alike, who will profit by the opening up of the nation's water-power resources.

Highways and Heavy Haulage

SHARP increases in motor vehicle transportation, the appearance now and then upon the public highways of excessively loaded commercial vehicles, and the failure of many so-called durable pavements have drawn wide attention recently to the question of how far motor

vehicles should influence the design of modern pavements. The most recent state to become alarmed over the condition of its highways is Ohio, which has suffered greatly within the past few months. Recent transportation conditions have contrived to give great impetus to the commercial motor vehicle on short and medium-distance hauls. In fact, many communities have depended largely upon the motor truck for their supplies of farm and dairy products. In some states the heavy war traffic of 1918 has been reported doubled by 1920 commercial traffic. A cry has consequently gone up from various states insisting upon weight regulations for vehicles as a means of safeguarding the highways. It appears that, in the breaking up of highways, motor trucks and poor drainage facilities share the responsibility. Weight regulations must, therefore, be enforced to absolve the motor truck. Only intensive study and careful design, followed by proper construction, can eliminate poor highway drainage. But just what that limitation in truck weight should be is a question that automotive and highway engineers are to solve. There is apparently no adverse criticism regarding the lighter trucks, those below a 3½-ton capacity, the mass of criticism of truck weights being directed against heavy units. Highway technic which endeavors to discover what design will meet reasonable demands of highway transportation is in a formative period. Until that design is determined it is apparent that regulation is the only alternative whereby existing mileages can be saved. And it must be remembered that not only are the demands of highway transportation to be taken into account, but that financial considerations rule as well. If 25-ton loads are to form the basis on which highway engineers design modern pavements it is apparent that only the smallest mileages can be constructed. There is that middle ground: A thorough co-operation between those who build the highways and those who construct the vehicles using them, and expenditures based on economic necessity

Ship Railways: 700 B. C. to 1920 A. D.

ANCIENT and modern history of the engineering development of the ship railway for transporting vessels across necks of land is brought to mind by the description of the marine railway or slipway at Astoria, Ore., for hauling vessels out of the water to be repaired or cleaned, described in our issue of June 10, p. 1157. The ship railway and the marine railway belong to the same type, though employed for different purposes.

Historically, the ship railway dates back to about 700 B. C., when the Greeks built such a line to transport their galleys across the Isthmus of Corinth in order to avoid the long and dangerous southward passage. This line is said to have been in use for more than 300 years. Some other ancient temporary works of this kind were mainly achievements in military or naval welfare. There is record of lines built by the Greeks in 831 A.D., by the Venetians in 1438 at Lake Garda, and by the Turks in 1453 at Constantinople. In American history there stands prominently the Portage Railway, of about 1840, for the transfer of canal boats across the summit of the Alleghenies. Coming down to more modern days, in the decade of 1880-1890 the project for an Atlantic-Pacific ship railway across the Isthmus of Tehuantepec, in Mexico, was advocated vigorously and was a subject of interest and controversy in engineering circles as an alternative to or a rival of the several isthmian canal projects of that time. A few years later the Chignecto ship railway in Nova Scotia, at the head of the Bay of Fundy, was commenced, but financial troubles led to the abandonment of the work. Of a smaller class are the Dalles-Celilo boat railway for transferring river vesels around the rapids of the Columbia River, and the boat railways for transferring small craft over dams and levees.

The Tehuantepec project deserves particular attention because Captain Eads was its engineer and promoter and it had the endorsement of such men as Octave Chanute, Henry Flad and E. L. Corthell. For transportation purposes on such a large scale the shipyard railway or slipway had to be developed along somewhat different and original lines. Instead of raising the cradle into contact with the ship by hauling the cradle up an incline, Captain Eads proposed to raise it vertically by a submersible pontoon traveling in guides. For hauling over a long distance the cradle was to be mounted on railway trucks instead of rollers, and chain or cable haulage was to be replaced by locomotive traction. Further, some better support than the ordinary bilge blocks would be needed to prevent straining or racking of the hull of a large steamer during the land passage. To meet this requirement a system of equalized hydraulic jacks was devised, a combination used successfully in recent years for moving large bridges.

Ships of 5,000 tons were provided for in Captain Eads plans. Since his day, however, there has been such increase in the size and weight of ships that many of the vessels which now go through the Panama Canal would still have to go around Cape Horn if the Tehuantepec ship railway were the only means of interoceanic communication. The same condition might exist if we had only a canal of the dimensions proposed in the projects contemporaneous with the ship railway. But the railway was so much the cheaper that it would have been easier to supersede it by a large canal than to enlarge or replace an existing canal. Difficulty of finance appears to have been the main obstacle which this ship railway project, like several canal projects, could not overcome. What might have been the history of isthmian transportation if the railway had been built can be only a matter of conjecture.

Whatever may be the possibilities and limitations of the ship railway, there is no doubt as to the practical value of the marine railway for shipyard work. Although a 5,000-ton load limit is assumed by the author of the article already mentioned, it seems not improbable that such railways may be developed for larger capacities and still show advantages of economy as compared with either fixed or floating drydocks. Foundation conditions and cost are prime factors in such development.

War conditions have been the cause of a rapid introduction of marine railways for shipyard work in this country, coincident with the revival of the American shipping industry. Their continued use will be a part of the maintenance work on our new merchant marine and may lead to further developments in size and in operating methods. It may be that engineers will again consider the possible application of the ship railway for transportation in commercial or military service, not necessarily for liners or battleships but perhaps for transfer of coasting vessels or the smaller class of war vessels between fields of operation in separated waters.

Another Turn in Rail Study

WITHIN the past two years the discovery of a new method of rail study, "deep etching," or pickling, which revealed a startling condition of the interior metal of many rails, wakened hopes of new progress toward greater railway safety. Later, when it was demonstrated that the peculiar internal defects revealed by pickling are due to numerous fine cracks in the steel, and when various observations had made it highly probable that this internally cracked or "shattered" condition of the metal is closely related to the occurrence of transverse fissures, such hopes were strengthened. It seemed that nothing remained but to find the cause of internal cracking and then to cure it, in order to eliminate the most troublesome and dangerous type of rail failure. But the reassuring prospect is now made rather more remote by conclusions drawn from further studies of rails, and if those conclusions are confirmed the whole rail subject may revert to its unsatisfactory status of three or four years ago, when each new fact brought to light in rail study seemed to introduce greater confusion.

In summarizing elaborate investigations made in connection with a Virginia train wreck caused by a transverse fissure, J. E. Howard, of the Interstate Commerce Commission, virtually declares the theory that fissures are caused by "shattered" metal in the rail head to be unfounded. He cites some bad cases of transverse fissure that occurred in rails free from the internal cracks revealed by deep etching; and obviously it is hard to reconcile the theory with such observations. But in his report and in a subsequent paper read at the meeting of the American Society for Testing Materials two weeks ago he goes beyond refuting the theory, and suggests that its very opposite may be true, namely that shattered rail-head metal may be more resistant to fissuring than solid metal. This disconcerting view, put forward quite insistently in the wreck report, is stated in the later paper much more cautiously, as merely a question entitled to consideration and study; yet for the moment at least it is the newest thought in the field of rail study and must be reckoned with.

Transverse-fissure breaks, it is agreed, are repeated-stress fractures that start from some minute defect in the metal. The service stresses in the rail should, however, be greatest at top of head and bottom of base, whereas the center of a transverse fissure is always located in the interior of the head. For this reason, when Mr. Howard first announced his discovery of transverse fissures, eight or nine years ago, he pointed out the controlling influence of the cold-rolling action of the wheels, which distorts the surface metal of the rail and transfers the zone of maximum tensile stress to the interior. Now he couples with this effect the influence of initial strains in the interior of the head caused by the shrinkage of the rail during cooling after it leaves the rolls, in the process of manufacture.

The rail metal cools first on its outer surface and the shell thus becomes rigid; and when the hotter interior metal then shrinks, longitudinal tension in the center of the rail head is set up. Such action does take place no doubt, but in naming it as a prime factor in transverse fissuring and attributing fissures to "the united action of the primitive shrinkage strains and the augmented cold rolling strains," Mr. Howard sets up a wholly new conception of the mechanical action of rails.

But directly connected with this new view is a conclusion drawn from the peculiar fact that in a rail whose interior is "shattered," the zone of shattering ends half an inch or so from the (hot-sawed) end of the rail, just as it does not approach nearer the sides and top of the rail than half an inch or so. M. H. Wickhorst, engineer to the railways' committee on rail study, confirms this observation, and both Mr. Howard and Mr. Wickhorst conclude that the shattering develops after the hot-sawing and is a manifestation of the shrinkage which occurs during the cooling of the rail. Mr. Howard goes farther in his reasoning, and considers that in those rails in which shattering develops during the shrinkage, the strains that would otherwise be set up are relieved, and that in consequence sound rails have greater initial stresses and are more susceptible to failure by transverse fissuring. Therefore, "the diffusive action of a certain number of shattering cracks might at times ameliorate conditions, retard or possibly arrest the formation of transverse fissures."

With all possible allowance for the harmful effect of initial strains, it is not easy to understand how a thoroughly checked and cracked mass of material can be more resistant than solid material to the tearing-apart action evidenced in transverse fissuring. Mr. Howard's conclusions are of undoubted weight, in view of his long study of rail fissures and his rare skill as an investigator. But unless his theory can account for the fact that fissures tend to occur in heats, for the greater susceptibility of heavy over light rails, and for the protective effect of reheating blooms before final rolling—all facts that point the finger of suspicion at ingot conditions—it is obviously so imperfect as to be merely a speculative hypothesis.

The most uncomfortable feature of these latest views is that they lead again to putting the blame for transverse fissures on rail service rather than rail quality. In his wreck report Mr. Howard goes so far as to say: "The idea is not tenable that unbreakable rails can be made, ignoring service stresses; that rails must be made as a mill problem which will not fail in the track under the increasing weight of rolling stock." This is in substantial opposition to the views on which present work on rail specifications is being carried on. Railway engineers, while recognizing the existence of high service stresses, fully established by the work of the Track Stress Committee, point to many facts that acquit stresses of primary responsibility for failures: the simple fact, for instance, that rail failures are not proportioned to traffic weight or density. Such facts argue against the new views just as they have overthrown prior attempts to explain rail failures.

In time it may be possible to place the subject of railway track on the basis of design, and to limit the stresses caused by trains in the same way that bridge stresses are limited. But for the present we believe that the problem must be regarded essentially as one of rail quality—finding out what defect causes some rails (very few) to fail. From this point of view the study of "shattering" of rail-head metal still appears highly promising, indeed the most promising in the whole rail field, despite Mr. Howard's recent conclusions. And it may indeed turn out that the early acquittal of shattering cracks from responsibility for transverse fissures was premature. Even the conclusion that shattering is caused by shrinkage may prove to be in error, and the mechanical actions of the steel-mill rolls may yet be shown to play a part in determining rail quality.

Structural Design and Ventilation of Liberty Tunnels

Two Tunnels 59 Ft. Apart Provide Separate Two-Line Roadways—Light Traffic Likely for Many Years—Ventilation

IN the Liberty Tunnels through the South Hills, now under construction, Pittsburgh will have the largest highway tunnel yet built. It is notable both in its size of cross-section and in its length; it provides two separate roadways, each for two lines of traffic with space for street cars, and its length from portal to portal is well over a mile, being 5,715 ft. After the adoption of the general route, reported in *Engineering News-Record* of July 24, 1919, p. 166, the project as originally outlined was thoroughly revised in the course of working out the details. A wide four-line tunnel was contemplated a year ago, but this plan has been superseded by the present one for two separate two-line tunnels. The profile of the route was improved by eliminating the summit and steep grade laid out last year, and substituting an unbroken flat grade of 0.329 per cent. The enterprise is significant in its engineering phases on the traffic as well as on the structural side. Providing adequate ventilation to purify the tunnel air of the dangerous exhaust gases from automobiles was one of the most important problems of the planning.

Ground Conditions and Lining—The tunnel lies in good shale. The top of a ledge of especially firm sandstone that has been used extensively for producing local building stone occurs near springing-line elevation. The tunnel practically follows the strata. It was to be expected that blasting in construction would loosen the roof in places sufficiently to cause large overbreakage, but not enough to develop any material rock loading on the structure of the tunnel. The lining was therefore designed empirically as a 24-in. arch of concrete, lightly reinforced along the intrados to forestall any possible cracking. The cross-section of each of the two tubes is of horseshoe outline with semi-circular roof arch 13 ft. 3½ in. in radius and sidewalls 7 ft. 2 in. high above crown of roadway.

To fill the space back of the lining rock packing as customary is provided for, but this is required to be cemented solid with grout pumped through pipes set in the lining. The two tubes are 59 ft. apart on centers, leaving about 27 ft. of undisturbed rock between the separate excavations.

Abandoned coal workings about 150 ft. above the tunnel drain the upper part of the hill over the tunnel, but the rock below the workings probably contains water. As it was feared that wet places might be encountered in the excavation, especially near the portals where the ground is presumably most broken, it is required that for 600 ft. length at each portal, and wherever else the engineer might find desirable, membrane waterproofing shall be placed on the outside of the lining concrete.

According to the contract plans of A. D. Neeld, engineer in charge of the tunnel construction for Allegheny County, the tunnel excavation is to be timbered with arch sets of 12 x 12 timbers outside the neat line of the concrete lining, these sets to be spaced as may be found necessary for the support of the rock. When the contractor, Booth & Flinn Ltd., of Pittsburgh, started on the work, it was found that with the price of timber at $65 per M. it would be cheaper to use 8-in. Bethlehem H-beams cut to form segments as for timbering. The substitution has been approved by the engineer, and in view of the greater permanency of the substituted material the I-beams will be allowed to project 6 in. inside the exterior neat line of the lining. The excavation and hence also the overbreakage will probably be much reduced by the change.

Traffic Conditions—A district of purely residential character is to be served by the tunnel. The suburbs West Liberty, Beechview, Brookline, Dormont, Mt. Lebanon and adjacent territory, which lie beyond the south portal, are not likely to become sites for industrial development in future, and but little development of traffic beyond a growth of the passenger vehicle traffic is looked for. The only freight transport through the tunnel will be that necessary for building materials and for the domestic services of the district. It was believed unwise to build a tunnel of less than one two-line roadway in each direction, but the maximum capacity of the tunnel will probably not be utilized for many years to come. Before traffic outgrows this capacity another tunnel may be built, reaching another part of the South Hills district.

According to calculations checked by traffic studies on Pittsburgh thoroughfares the tunnel capacity is estimated at 1,690 vehicles per hour in each direction, at the maximum. This traffic corresponds to two lines of vehicles, both traveling at 15 miles per hour, vehicles 100 ft. apart in each line. A traffic count made on Bigelow Boulevard, the principal automobile thoroughfare between downtown Pittsburgh and the east end, conducted during a recent stoppage of street-car traffic, when presumably the road traffic was heaviest, showed a maximum of 1350 vehicles passing in one direction in one hour. This traffic occupied half the width of the 40-ft. roadway, and so is considered fairly comparable with the possible traffic in one roadway of the tunnel. It will be seen that the tunnel capacity has been estimated

FIG. 1. SOUTH PORTAL OF WEST TUBE, LIBERTY TUNNELS, FROM BELL TAVERN

at a higher figure. The ventilation calculations were based on this estimate of capacity.

Ventilation—Tests of automobiles for carbon monoxide emission and physiological experiments on the susceptibility of human beings to carbon monoxide now being conducted under the auspices of the Bureau of Mines, supplied the essential data for the calculations on ventilation. As this is the first large highway tunnel in which the problem of dealing with automobile exhaust had to be solved, there was no precedent to guide the planning. While the assumed data differ from those used in the design of the Hudson River vehicle tunnel at New York, the results are said to be substantially identical.

It was believed that with the above-noted spacing of vehicles (100 ft. in each line), corresponding to 114 automobiles in either tube of the tunnel at any one time (in maximum traffic), heaviest load would be fairly represented by assuming a gross weight of two tons per vehicle. The monoxide emission was taken as 3.0 cu.ft. per ton-mile. Since a vehicle of two tons traveling at 15 miles per hour represents a transportation unit of ½ ton-mile per minute, the carbon monoxide emission under these conditions would be 1.5 cu.ft. per vehicle per minute or 170 cu.ft. per minute for each tube of the tunnel. From the curves showing the physiological results it was considered that a carbon monoxide content of 6 parts per 10,000 at the exit (or half that quantity average) would be allowable. Therefore it would be necessary to supply 280,000 cu.ft. of fresh air per minute to each tube.

After consultation with Charles S. Churchill it was decided to use the system designed by Saccardo for ventilating tunnels in Italy. This system with some modifications Mr. Churchill has used in ventilating a large number of railroad tunnels in the United States. Air is blown in at one end of the tunnel by means of suitable lateral nozzles facing toward the other end of the tunnel, and the tunnel itself is utilized as ventilation duct. It was at first intended to take advantage of the prevailing winds, which are from the south, by ventilating from south to north in both tubes, but this was reconsidered as it would mean ventilation against the traffic in one tube. The final decision was to ventilate with the traffic. As the total air pumpage, distributed over the cross-section of the tube, 468 sq.ft., means a velocity of air current of only about 6 miles per hour, there is a likelihood that the traffic will aid in driving the air through the tunnel. Two pumping plants, one at the entrance end of each tube, will be designed for handling the entire quantity of air required at maximum traffic. An emergency maximum pumpage of 280,000 cu.ft. per minute per tube, or a normal maximum of 200,000, has been assumed for the design of these plants.

A pair of nozzles in the side walls of the tunnel near the entrance end, leading from an air chamber formed in an enlargement of the tunnel excavation surrounding the lining, will give a discharge area for ventilation air of 68 sq.ft. (for one tube). With the normal pumpage the discharge velocity at the nozzle will be 2,940 ft. per min., or about 33 miles per hour, and with the maximum pumpage the discharge velocity would be 4,210 ft. per min., or about 47 miles per hour; this maximum would be needed only in cases of emergency. The mechanical details of the ventilating plant have not yet been worked out. The figures given are tentative and subject to change after the Bureau of Mines has completed its investigations.

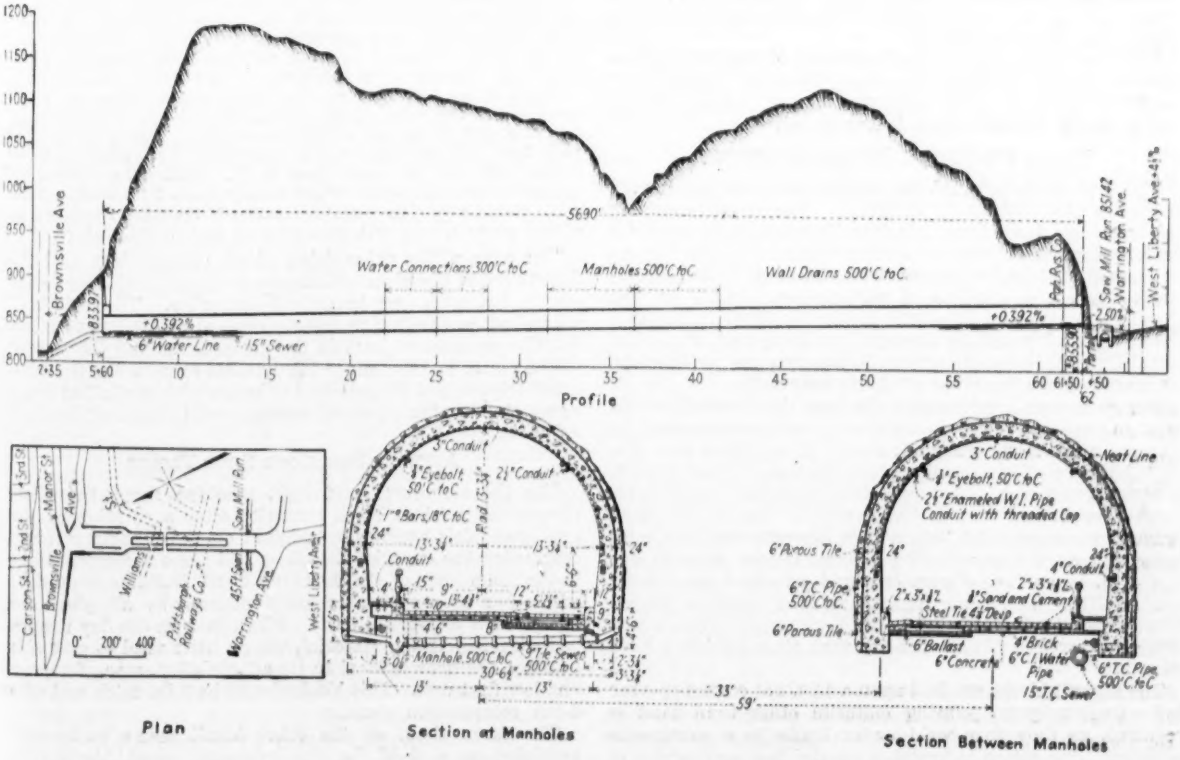

FIG. 2. PROFILE AND CROSS-SECTION OF DOUBLE-TUBE HIGHWAY TUNNEL THROUGH SOUTH HILLS, PITTSBURGH; LENGTH 5,715 FEET

Factory Floors for Special Uses

Types Recommended by Experiences in Navy for Acid-Subjected Floors and for Different Kinds of Storehouses and Workshops

By H. S. Rinker
Expert Aid, Navy Yard, New York

This paper appeared in "Bulletin No. 31," Public Works of the Navy, April, 1920, which is issued under the cognizance of the Bureau of Yards and Docks and the Corps of Civil Engineers, U. S. Navy.

THE urgent impetus given by the war necessities of the Navy's shore stations resulted in a strong demand for more and better industrial buildings, and the advance in design has been commensurate with the requirements of the times. The old-fashioned way of arranging the interior of any building, walls and roof, which might fall into the possession of the department requiring accommodations, has changed.

This has brought with it the question of special design—of making a building just as much a part of a special service as a machine tool or piece of equipment. We now make storehouses, machine shops, galvanizing plants, foundries, plate and angle shops, smithies, each for its own purpose, each with the special construction—steel, concrete, wood, or composite—which adapts it to its purpose.

This revolutionary departure in frame, lighting, crane, and elevator equipment is accompanied by a corresponding need for floors of such special construction as to fit into the purpose of the building as exactly and with the same adaptability as the other portions of the structure.

While discussing the question of floors in general, the conclusion was forced on the writer that the matter had been given but little detailed attention, the general opinion being that for a shop the floor should be either creosoted wood block, or concrete, usually with some surfacing process included. The average engineering imagination has no further to go to find a satisfactory type. But when the special problem requires a special solution the adaptability of these types is not always marked.

Problems which have recently come to the writer's attention are those of floors for storage-battery storage and overhaul buildings, galvanizing plants, light machine shops, and buildings for toilet and locker rooms.

Floors for Storage-Battery Buildings

The first of these problems to arise was the question of floors for storage-battery buildings. The requirements in this case are that floors shall be dense enough to resist deformation under the concentrated weight of the battery units, ranging to 1,000 lb. per square foot; shall be impervious to moisture, capable of withstanding attack by the chemical agents and products incidental to charging, discharging, and handling storage batteries; and shall still remain plastic long enough to resist abrasion or fracture by reason of the handling of the battery cells.

The main consideration, that the floor shall be and remain inert to chemical action, is filled to an admirable degree by a special acid-resisting asphalt block. The problem was submitted to one of the leading asphalt-block manufacturers in connection with the storage-battery building at the Philadelphia yard, and was solved satisfactorily, as has been proved by severe tests, both at the laboratory of the company and at the yard. The asphalt blocks selected are 8 x 4 in. in surface dimensions, and admit of repairs by simply lifting and reversing the injured block or blocks. The manufacturing pressure is 4 tons per square inch, which insures a product of such density that standing loads have no effect.

The asphalt blocks are laid upon a ½-in. 1:4 cement-mortar bed. Ordinarily no jointing material other than sand is required, as they soon weld under traffic to a continuous surface. This action is hastened by the fine sand which is spread over the surface of the floor and allowed to work into the joints.

In those localities in which traffic is insufficient to produce this sealing action one of two methods may be adopted to insure a moisture-proof acid-resisting point. One of these is the use of an asphaltic filler. This, however, is open to the objection of extra expense, and conceivably might also result in some stickiness on the floor surface. The other method consists, briefly, in applying a surface coat or thin wash of liquid asphalt, which fills and seals all the joints. In the case of the Philadelphia yard it was considered that the traffic would not be entirely sufficient to close the joints. Should the application not be considered necessary at first, this surface coat may be easily and quickly applied at any time.

In all these cases the concrete subfloor and the mortar bed are laid perfectly true to the necessary drainage grades, and the finish grades follow the subfloor grades to vitrified earthenware drainage cesspools set at appropriate points, which in turn connect with vitrified-pipe drains.

Making the Sub-Floor Acid Proof

Replying to an inquiry as to methods of positively sealing the floor so as to preclude the possibility of acid reaching the concrete sub-floor, the manufacturers referred to above made the following statement:

We note that the department which will use this building is interested in the manner in which the joints of the asphalt block may be sealed, so that no acid can pass through to the concrete floor below. The maltha to which our letter refers is a heavy petroleum oil having an asphaltic base. In order to secure a flux for the Trinidad asphalt which is used in the block, we refine the above maltha until it becomes solid. It then has a consistency similar to rubber and imparts to the block its peculiar resiliency. This flux or asphaltic residuum from maltha is pure bitumen, and acid acts upon it only very slightly and with extreme slowness. The melting point is about 140 deg. F., and it is this material that we suggest for a paint coat. The maltha or its residuum, for we use the terms interchangeably in our own process, should be heated to about 400 deg. F., and a coat spread upon the surface of the blocks. This coat should be made as thin as possible and should be squeeged. A thin layer of fine, clean sand should be spread over the entire surface and allowed to be worked in by traffic. The surface to be coated should be dry and clean, and the process of coating should be as rapid as possible and performed while the material is hot. Any excess sand may be brushed off after the paint coat is cooled. You will note that by this means a floor is obtained which is entirely impervious to moisture. Care should be taken with each of the above processes.

There is no limestone in these blocks, the aggregate being composed of trap. It is necessary in the manufacture of a block to use a certain amount of dust as a filler. This dust is trap-rock dust. We note that the bed on which the blocks are to be placed will not be more than ¼ in. thick. Our invariable procedure is to use a mortar bed usually about ½ in. thick. There is no reason why ¼ in. would not suffice if the mortar bed can be struck off to a true and even level in such a thin layer.

The case of the galvanizing plant, copper shop, and the floors around the plate-pickling tanks is fairly similar to the above, but with one important exception. The acid and alkali baths introduce the same chemical problems as before, but the presence of heat in the metal baths and the weight of the plates handled make it advisable to pave the floor immediately around the metal-bath tanks with a vitrified brick of selected attributes, set in asphalt, and the rest of the floor as above.

Asphalt Block for Shop Floors

For the structural and light machine shops the plain compressed asphalt block seems to offer a solution of the problem. This conclusion is based on the reports received concerning the experimental floor laid some three years ago in the boiler shop of the Brooklyn Yard, Building 28, a floor which has been enthusiastically indorsed by all who have examined it or worked on it. When laid on the dry mortar bed without jointing material, with a little sand to give side bearing, the floor is ideal in its adaptability, ease of repair, and low first cost. This block should be 2 in. thick and of a 4-ton compression density.

The forge shop, on the other hand, seems to be still available as a field for the creosoted wood block. Its peculiar drawbacks—the necessity for jointing with pitch and the consequent "bleeding," so noticeable when it is used

for outside work—are reduced to a minimum here by reason of the protection from sunlight afforded; and the sand and iron scale, always present, soon become so indurated by incorporation into the ends of the wood fibers as to make a resulting surface entirely different in appearance and action from the same material when exposed to weather conditions.

Such a floor is available for shops with small fires and handwork without any special protection from hot forgings dropped on it, provided the forges are furnished with an area of sanded surface adjacent to the fires. Where large furnaces are located, the provision of an appropriate area paved with granite block or lug brick is advisable. This, however, should be reduced to a minimum for the sake of the workmen.

In toilet rooms the granolithic floor is still, all things considered, regarded as worthy of first choice. When it is made integral with the floor, properly floated, and steel troweled at least three times, as it should be, it answers every purpose. In all cases it should extend in unbroken construction at least 8 in. up on the side walls, with a sanitary cove at least 2 in. in radius. The receptors and drainage grades for showers and toilet fixtures can be made integral in this surface finish, terminating in brass cesspools connected to the drainage system.

This material, however, does not seem to be necessary in the locker rooms, where edge-grain or end-grain wood flooring may be used with entire satisfaction. The continuous mastic sheet floor, however, would seem to be the most desirable for this situation, as it lends itself to cleansing with water or antiseptic solutions as well as the granolithic finish, and also admits of the integral sanitary cove at the junction of wall and floor, without presenting the chill and unyielding surface of concrete.

The cost of the 1¼ in. compressed asphalt block used in the battery building at the Philadelphia Navy Yard are approximately as shown below:

	Per square yard
8 x 4 x 1¼ in. block at plant	$1.35
Freight and laying	.35
Concrete base and mortar bed	1.00
Asphaltic seal for joints	.20
Cost per square yard at Philadelphia	$2.90

This is by far the cheapest floor on the market today, as by comparison with recent figures its first cost is less than that of either brick or wood block, and its maintenance expense negligible

Water-Works Repairs and Replacement

IN THE course of a discussion on the legitimate use of water prepared for the recent convention of the American Water-Works Association, George A. Johnson, consulting engineer, New York City raised some questions regarding posible water-works economies in other lines than water waste restriction during the present period of high prices. He said:

Is it possible that in the downfly prosperous days of the past we replaced at high cost where we could just as well have repaired at small expense? Have we laid new mains, built storage reservoirs and installed new pumping units in order to obtain more water when we could have accomplished the same end effectively by searching out and stopping unnecessary waste of water, installing meters, cleaning mains to restore their original capacity thereby cutting down friction losses and saving the coal pile and generally attending strictly to our job?

There seems to be real occasion for serious debate respecting whether the war period, and the manner in which we lived through it, has not furnished a lesson which most of us refuse to understand, namely, that it really is possible to get satisfactory service on a restricted program of water-works extension, machinery replacement and the like, if we pay more attention to economy in all lines and exploit the more economical potentialities at hand to a far greater extent than we did before the war. It seems to be deplorably true that quite on the contrary, as an average proposition, we have followed the line of least resistance when water consumption threatened to exceed supply.

Effect of Inert Powders on Concrete Srength

Tests Showing That Hydrated Lime and Other Powders Except Slag Tend Slightly To Decrease Compressive Strength

TESTS reported by Duff A. Abrams, of the Structural Materials Testing Laboratory at Lewis Institute, before the recent meeting of the American Society for Testing Materials give some rather unexpected results regarding the strength of concrete to which has been added inert powdered admixtures, mainly hydrated lime. As stated in the paper, "The use of hydrated lime in quantities up to 5 or 10 per cent of the weight of the cement has gained considerable vogue due to the feeling that it improves the workability of concrete, or increases the strength and watertightness. Published tests may be found which appear to support the above conclusion. However, it will be seen that these more thorough tests show the error of the statement with reference to strength and workability. Water-tightness was not studied in this investigation."

The tests have been made over a period of four years and involve nearly 20,000 test pieces. The report is confined to powdered admixtures which are essentially inert in the presence of water and cement as contrasted with liquids or soluble materials, and while the major portion of the tests were made with hydrated lime seventeen other materials were also used in order to determine the general effect of inert powdered admixtures.

Tests were made mainly on 6 x 12-in. concrete cylinders, although some tension and compression tests of mortar were used. Wear tests were made in the Talbot-Jones rattler, and bond tests were made in one series. Studies of evaporation and absorption were made on concrete containing hydrated lime and other admixtures. The mix varied from a 1:2 to 1:9, with wide variations in consistencies, and size and grading of aggregates, and the age tests varied from three days to one and one half years.

The general conclusions as stated in the paper are as follows:

1. In general the addition of powdered materials reduced the strength of concrete approximately in proportion to the quantity of admixture. Some exceptions are noted.

2. In usual mixtures each 1 per cent of hydrated lime (in terms of the volume of cement) reduced the strength of concrete 0.5 per cent. The reduction in strength caused by replacing cement with an equal volume of hydrated lime was about 1¾ times that caused by adding hydrated lime.

3. High calcium and high magnesium limes produce the same effect.

4. The addition of 1 per cent of the following powdered admixtures in terms of the volume of cement reduce the strength of 1:4 concrete at 28 days by the following percentages:

Brick, 0.08; clay, 0.22; whiting, 0.24; sand, 0.37; natural cement, 0.38; limestone, 0.39; lava, 0.40; fluorspar, 0.43; kaolin, 0.47; kieselguhr, 0.48; tufa, 0.51; hydrated lime, 0.56; ironite, 0.60; yellow ochre, 0.68; mica, 1.10; pitch, 1.50; gypsum, 4.00. For the same conditions the addition of 1 per cent of cement *increased* the strength of concrete about 1 per cent.

5. Pulverized slag up to 50 per cent of volume of cement gave a slight increase in strength of concrete (about 0.12 on the basis used above).

6. Rich concrete mixes showed a greater loss in strength due to powdered admixtures than the leaner ones. Very

lean mixes (1:9 to 1:6) and in those with aggregates graded too coarse for the quantity of cement used, the strength was little affected or was slightly increased by admixtures up to 50 per cent.

7. The wetter mixes showed a greater loss in strength than the dry, due to the addition of hydrated lime.

8. The effect of admixtures was in general independent of the age of the concrete.

9. Sand and slag cements gave results comparable to those from powdered materials simply mixed in the concrete.

10. Hydrated lime and other powdered admixtures used in these tests slightly increased the workability of the leaner mixes (1:9 and 1:6) as measured by the slump test. Ordinary mixes (1:5 and 1:4) were little affected; richer mixes (1:3 and 1:2) were made less plastic.

11. The wear of concrete was not sensibly increased by hydrated lime or other admixtures up to 20 per cent of the volume of cement.

12. The bond resistance was affected in the same manner as the strength by the presence of hydrated lime.

13. Hydrated lime had little effect on the absorption of dry concrete, increased the evaporation of water from wet concrete and produced no beneficial effect on the strength of concrete stored in air.

14. The yield of concrete was little effected by hydrated lime or other admixtures; for the usual concrete mixes, 20 per cent admixture increased the yield about 2.5 per cent.

The conclusions of Professor Abrams' paper were attacked quite vigorously at the convention by several of those interested in the use of hydrated lime. C. M. Upham, state highway engineer of Delaware has been making a number of field experiments with hydrated lime in concrete and has been using it in his concrete roads; he stated that his observation of the tables included in the Abrams report showed that while they applied to the high percentages of admixture of hydrated lime, they were not entirely true for such mixtures as are used in actual practice; that is, speaking generally, for a 5 per cent to 10 per cent admixture in a 1:6 concrete. He said that casual examination of the tables seemed to show that in few cases was the strength of 1:6 concrete reduced by a 5 per cent admixture and that in some cases it was increased. Professor Abrams, however, in reply insisted that while some of the strengths of concrete cited were higher with the lime admixture, the general statements and conclusions he thought were borne out by the tests. He stated further that the tests did not bear out the occasional contention that hydrated lime in concrete serves to store up surplus water to be delivered to the cement for hydration at a later period.

Sanitary Control of Water Supplies in Quebec

The Board of Health of the Province of Quebec, said T. J. Lafreniere, sanitary engineer of the Board, in a paper at the annual meeting of the American Water-Works Association, has power to order that publicly owned water supplies be made safe. Local authorities may incur the necessary expense without authorization by popular vote. Until the passage of legislation in 1919, the board had no such control over privately-owned supplies, which were under the jurisdiction of the Public Utility Commission. The 1919 legislation leaves to the commission the decision as to how the cost of improving the quality of privately owned supplies shall be met. It is probable, Mr. Lafreniere said, that if the water rate payers will not agree to an increase in water rates to meet the added cost of providing safer water, then the municipality will have to carry the burden.

New Rapid Transit Railway for Sydney, Australia

Electric Underground and Elevated City Loop To Connect Suburban Lines and Relieve Street-Car Congestion

ELECTRIFICATION of steam suburban line. and their extension through the city, with a connection across the harbor to the northern suburbs, is the costly project undertaken to provide much needed improvement in the rapid transit facilities of Sydney, New South Wales. It is expected that construction work, interrupted by the war, will be resumed this year. The harbor will be crossed by a cantilever bridge of 1,600 ft. clear span, carrying the suburban tracks, street railway tracks and roadways. The following information regarding the project has been obtained through the Railway Commissioners, the railways and street railways being owned and operated by the government of New South Wales, Rapid growth of population and great development of local traffic have resulted in extreme congestion of the city's transportation facilities. The population grew from 488,000 in 1901 to 520,000 in 1905 and 877,000 in 1910. There was a drop to 771,000 in 1917, but since there has been an increase, so that the present population is probably about 800,000. Street railway passengers increased from 120,974,000 in 1905 to 244,712,200 in 1917, the miles of line being 73 and 113 respectively. For the year ending with June, 1919, the number dropped to 222,111,400, but this was only a temporary check in the steady increase. Railway suburban passengers numbered 89,542,000 in 1919, but this includes the two cities of Sydney and Newcastle. Allowing 75 per cent for the larger city, it had 67,156,500 passengers, many of whom used also the street cars and the ferries

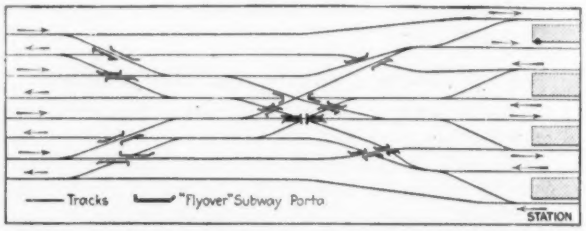

FIG. 1. GRADE SEPARATION OF TRACKS ON RAPID-TRANSIT RAILWAY

as part of their routes. The harbor separates the city from an extensive residential and suburban district on the north, and ten years ago the five main steam ferries carried 13,000,000 passengers annually and two carried 430,000 vehicles. Bridge and tunnel projects for crossing the neck of the harbor were described in *Engineering News*, July 29, 1909, p. 128.

Main line and suburban traffic of the steam railways now terminates at the Central Station, a large terminal one mile south of the business center of the city and 1½ miles south of the Circular Quay on the harbor front, where the ferry service is concentrated. From the quay to the railway station there are four electric car lines on four principal streets, one of these lines ending at the station and the others continuing to districts not served by the suburban railways. The Central Station was opened in 1906, but additional platforms had to be provided in 1914 owing to the

great increase in traffic. An unusual feature of this station (see *Engineering News*, March 30, 1905 p. 327) was the arrangement of the tracks in groups of three between the platforms, the middle track being used to run out the locomotive of an inbound train or to store cars and trains. Transfer tables connected the ends of the three tracks.

Street car service between the station and the ferries has practically reached the saturation point and it is said to be impossible to increase the accommodation during the evening rush hour. In two of the streets, two-car trains operate on a headway of only 17 sec., each car seating 80 passengers but often carrying twice that number. The steam suburban trains of the southern and western districts are handled at the Central Station, which is served by four inbound and four outbound tracks. During the evening rush hour there are 58 outbound trains, generally consisting of ten cars, the traffic being handled at 21 platforms.

To relieve this traffic congestion and to improve the service by reducing the transfer between trains, street cars and ferries, the suburban lines are to be extended beyond the Central Station terminal to form a loop through the city, with branches to eastern and western suburbs now served only by surface cars. Another line from the loop will extend across the new bridge to connect with an isolated suburban line which now terminates at Milson's Point on the northern side of the harbor. When the project is completed, the entire city and suburban service will be operated by electricity and much of the traffic now handled only by street cars will be served by the suburban trains, so that there will be no change of cars between suburban and city points. The general scheme is shown by the map, Fig. 2.

Connection with the main line of the steam railway system will be at Wells St., about ¾-mile south of the present terminal. Here eight tracks will be diverted to a new through station on the east side of the Central Station, a four-track approach leading to the latter, which will be used only for long-distance trains. At the connection, the eight tracks will be alternately inbound and outbound, but at the approach to the new station this arrangement will change to pairs of inbound and outbound tracks, a system of "flyovers" or grade separations being introduced so as to eliminate track crossings at grade. This arrangement is shown in Fig. 1.

Beyond the station, six-tracks on an elevated structure will extend to Campbell St., where the line goes underground on a grade of 1.3 per cent. Four tracks will then diverge to the west side of the loop and two to the east side. At Town Hall station, two of the four tracks will rise and two will continue underground to a double-deck station at Wynyard Square, the elevated tracks continuing across the bridge to North Sydney, where they will go underground as inidcated on the map.

From Wynyard Square, the low-level line will swing to the east and, owing to the topography, will emerge at Harrington St., continuing on a viaduct to a combined railway and ferry station at Circular Quay. At Macquarie St. it will go underground again and continue to a connection with the six-track line at Campbell St., thus completing the loop. Beyond the St. James station a double-track branch will lead off to the eastern suburbs, the connection being made by a "flyover" to avoid track crossings of busy lines.

The length of the loop from Wells St. will be a little over 5 miles, with 2½ miles below ground, 2 miles on the surface and the remainder on viaduct. No streets will be closed and all bridges will give ample headway for street cars. The maximum grades will be 3½ per cent and curves will not exceed 9½ deg., except for two short curves of 11½ deg. Transitions or easements will be used at all curves sharper then 4 deg. Underground construction will include both open cut and tunnel, with brick and concrete lining. All excavation will be in the hard Hawkesbury sandstone, which has nearly horizontal beds traversed by occasional thin bands of shale and overlaid by shale and clay. Steel frame construction will be used only where the headway is insufficient for the tunnel section.

Stations on the loop are about 2,600 ft. apart, with 520-ft. platforms, and are planned with a view to high traffic capacity. Allowing for a 30-sec. station stop, an acceleration of 1¼ miles per hour per second and a deceleration of 2 miles per hour per second, each of the six city tracks has a minimum capacity of 35 trains per hour. Both through and terminating trains

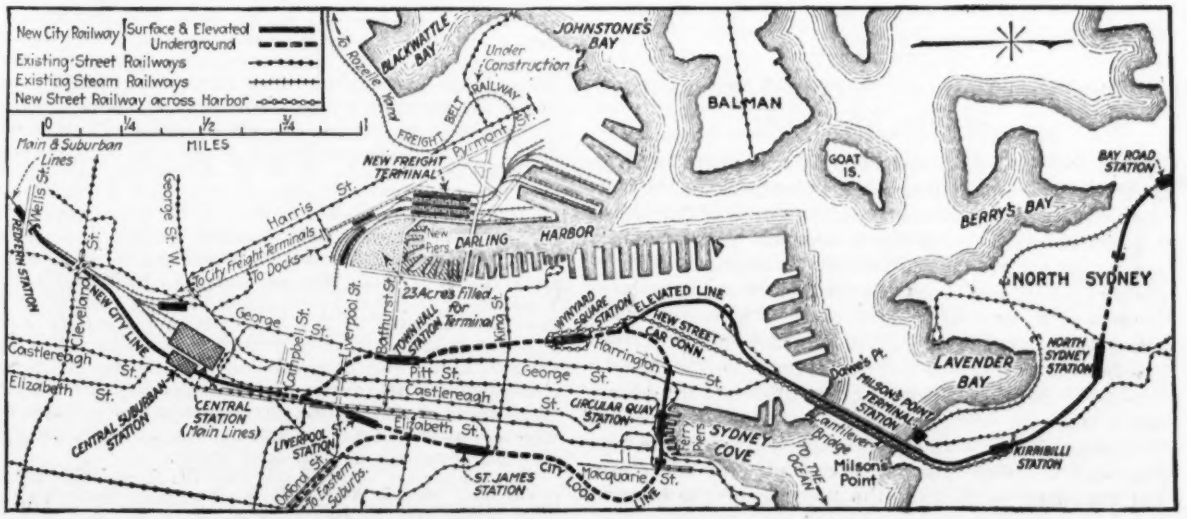

FIG. 2. RAPID TRANSIT LINES AT SYDNEY, AUSTRALIA

are provided for at Wynyard Square and St. James stations. To facilitate exchange of passengers at the Central and Town Hall stations each island platform is served by a pair of tracks for trains moving in the same direction. Ramps and passages are designed to provide for 30 to 35 passengers per foot of width per minute, stairways for 20 persons up and 20 down at the same rate, and escalators or moving stairways for 10,800 persons per hour.

The new elevated Central Station for suburban trains will have four island platforms and a capacity of 210 trains per hour. The ticket offices will be at the street level, in concourses passing under both ends of the station, with stairways to the platform. The Town Hall station under George St., one of the busiest thoroughfares of Sydney, will have two island platforms reached by stairs and subways. Its capacity will be 140 trains per hour. At Wynyard Square station there will be three island and two side platforms at each level, with a concourse between the two levels and approached by subways from adjacent streets. Its traffic capacity will be 200 trains per hour, including those which terminate at this point.

The Circular Quay station, 70 trains per hour, will have two side platforms 28 ft. above the street and approached by stairs and escalators. At the street level will be the ferry house, ferry offices, parcel check room, stores and a large restaurant. This building will have concrete piers sunk to rock at 20 to 55 ft. below the street surface. The St. James station, with two island platforms, will have a capacity of 130 trains per hour, including the branch trains terminating at this point. Liverpool St. station, with two side platforms will have a capacity of 70 trains per hour.

Construction work on this extensive project was commenced in June, 1916, being carried out by contract under the direction of J. J. C. Bradfield, chief engineer of metropolitan railway construction for the Railway Commissioners. Excavated material was used as filling for the freight terminal and docks at Darling Island, further up the harbor. Work proceeded until June, 1918, when the government considered it advisable to suspend operations temporarily owing to war conditions and the difficulty of obtaining plant and material. The estimated cost is £3,750,000, or about $18,750,000 at normal rate of exchange. This cost is exclusive of the Sydney Harbor cantilever bridge.

Port and Railway Terminal Works at Sydney, Australia

ADDITIONAL railway and harbor facilities for Sydney, New South Wales, are being provided at Darbor, West of the city and at the head of the land-locked bay on which the city is situated. An area of 23 acres at the inner end of Darling Harbor has been reclaimed by filling. Double-deck steel and concrete freight sheds are being built on long piers for ocean steamship service, and will be served by a waterfront railway connecting the city terminals with the freight belt line. At Glebe Island a grain elevator with a storage capacity of 6,500,000 bushels is under construction. In order to keep switching movements clear of the harbor work a freight yard with capacity for 3,000 cars has been built at Rozelle, the junction of the lines to the docks and to the grain elevator.

A freight belt line to serve the harbor was built some time ago owing to the very heavy passenger traffic on the main line. The latter has a general southeast direction to the city. The belt line begins at Rookwood, about 20 miles from Sydney, swinging north in a loop and passing under the main line to run south as far as Enfield, whence it runs east for some distance and then turns north, passing under the main line again at Lewisham and ending at the Rozelle yard mentioned above.

At Enfield is a gravity switching and classification yard with about 40 miles of track and capacity for 4,800 cars, the site being large enough to duplicate the capacity. An engine terminal with roundhouses and coaling station of the American type is established here, and the yard is said to be designed largely in accordance with American practice. A branch from the belt line connects with a second short main line from the south, so that freight service to and from the latter can be handled through the Enfield yard and thus kept out of the city terminals. The railway and harbor works are being constructed under the direction of the Railway Commissioners, the railways being owned and operated by the New South Wales government.

Standards of Water Analysis

Extracts from Report, Committee on Official Standards of Water Analysis, American Water Works Association, Jack Hinman, Jr., Chairman... Submitted at Montreal, June, 1920.

THE chief value of fixed standards lies in the simplification of the administrative control of water supplies, in the preparation of guarantees of filter performance and in the facilitating of the attempt to explain technical details to a non-technical body or to the public. A higher standard of relative purity may be required in an arbitrary manner, and in the effort to meet the standards plant operators may bring about a general improvement in water-supply conditions, as has resulted from the establishment of the United States Treasury Department standard with its governmental prestige. Any such standard must be used with discretion and with good judgement. In the hands of those who wish to use the standard in a rule-of-thumb manner, without taking into consideration all known factors, a fixed standard may become a dangerous weapon, able to destroy the good name of a satisfactory water supply.

The present Standard Methods of Water Analysis are prepared by committees of the American Public Health Association with the assistance of committees of the Society of American Bacteriologists, the American Chemical Society, and the referees of the Association of Official Agricultural Chemists. The work was begun about 1895, earlier work having been done by the American Association for the Advancement of Science. While committees of the American Water Works Association do not co-operate in the preparation of the report, the committees chosen by the other bodies have included members of this organization. Of those who have worked on the preparation of the various editions of the Standard Methods, A. P. H. A., 14 are members of this Association at the present time (list of September, 1919). These are Edward Bartow, J. W. Ellms, George W. Fuller, Allen Hazen, D. D. Jackson, George A. Johnson, E. O. Jordan, H. E. Jordan, W. P. Mason, W. F. Monfort, Earle B. Phelps, R. S. Weston, George C. Whipple, C.-E. A. Winslow. These men are probably the ones most likely to have been selected by this organization for similar work, although it is true that they were chosen and their work accepted by another body and one which is not exclusively concerned with the problem of water supply. It must be remembered, however, that that organization is concerned with sanitation and the protection of the health, rather than with the economics of furnishing water.

Your committee recommends that the Association accept the Fourth Edition of the Standard Methods of Water Analysis (A. P. H. A., 1920) as official.

Your committee recommends that unless at least 100 samples are comprised in the series under consideration, the B. coli index be not reported, and that where an adequate series is considered, the number of samples in the series, together with he dilutions used, be stated. For smaller numbers of samples, some method which does not represent the same degree of fictional accuracy is recommended. A common method of reporting is to express the percentage of positive tubes for each dilution, at the same time giving the number of samples and the number of tubes of each dilution planted. Another common method is the fractional method in which the denominator of a fraction represents the number of tubes planted and the numerator represents the number of positive tubes. Obviously the fraction for each dilution-size is given, together with the number of samples.

On account of its governmental prestige, the United States Treasury Department standard has perhaps been more generally accepted in the United States than any other standard. It has become the fixed standard of six states.

While the United States Treasury Department standard was claimed at the time of its promulgation to apply only to the water supply of the trains, and any intention to extend the standard to municipal supplies was emphatically disclaimed, the effect of the condemnation of the supply of a community and the posting of notices in the stations declaring the water unsafe has been to create a local pressure which has in many instances forced the improvement of the local supply. This is a matter of great and far-reaching importance in which it is evident the arbitrary standard of the United States Public Health Service has done much good. Your committee recommends to the members of this Association that they insist upon a thorough and complete sanitary survey, to be made, by preference, by the person who is to make the analysis or interpret the analytical findings, before any important report is made upon the plant under their control, whether the report is to be made by national, state or municipal authority, or for the information of the management of the plant.

Your committee, after full consideration of the question, cannot recommend any series of values as standard values for all classes of waters, nor for the waters of one class throughout America.

In making this recommendation it is not unmindful of the important influence of some arbitrary standards, nor of the possibilities of recent work on the operation of filter plants. In the judgment of the Committee such progress as is likely to be made soon in the matter of standards, is likely to come in the control of water plant construction and performance standards.

The committee would therefore submit the following as its definition, not of a "standard" water, but of a satisfactory one:

A water which is reasonably free from noticeable color, odor, taste and turbidity, which is reasonably free from objectionable salts in solution, which is free from injurious effects upon the human body, and which is produced and distributed in such a manner that its quality is practically certain to be maintained continuously in spite of accidents which can be expected in the operation the plant.

Will Study Low-Carbon Steel Worked at Blue Heat

Work is in progress to determine the effect on the mechanical properties of low-carbon steel, such as boiler plate, of working it at blue heat (300 deg. C.). The effect of low-temperature annealing on such plates will also be determined, and the mechanical properties at elevated temperatures will be measured. Study of the effect of rate of loading will be included in the latter work. For this purpose a motion-picture camera will be used to give records of the simultaneous positions of various moving dials. The Bureau of Standards, Washington, D. C., is carrying on the experiments.

Filter-Alum Making Experience of Montreal Water & Power Co.

Slightly Condensed From a Paper by James O. Meadows, Sanitary Engineer, Montreal Water & Power Co., before the American Water Works Association, June, 1920.

THE manufacture of filter alum by the above-named company at its filter plant in Montreal, P. Q., is saving the company $24,500 a year. The actual cost per ton, allowing 20 per cent capital charges, is $28.64, compared with $55 for commercial alum. The cost figures are based on the record of the last two years but the general operating data are drawn from an experience of four years.

The alum plant was installed with the idea of keeping the capital outlay as low as possible consistent with proper operation, because at the time it was thought that it would only be used for a comparatively short period of time. The plant consists of an acid storage tank, a dilute acid tank, bauxite weighing hopper, Stedman mixer, and concrete crystallizing tray. No crusher is provided, the filter alum being broken up into suitable sized lumps by hand sledges. (The plant is similar to those at Columbus, Ohio; Springfield, Mass.; Trenton, N. J., and Omaha, Neb.; see *Engineering News*, Jan. 4 and 11, 1917.)

By varying the temperature of the dilute acid the character of the alum can be modified. During the winter months a porous alum is desired because of its greater solubility and this product can be obtained by mixing the bauxite with a low temperature acid. During the balance of the year a filter alum of a more dense texture is secured by using a higher temperature acid. The temperature of the crystallizing tray floor is also a factor to be considered and it is necessary to use a higher temperature acid for Monday's batch because of the lower temperature of the tray floor after the Sunday rest. The temperature of the acid is controlled by agitation with compressed air and by a cooling coil placed at the bottom of the lead-lined dilute acid tank. By using the air and cooling coil for different periods of time a dilute acid of the desired temperature can be obtained.

To secure a uniform product from day to day care must be taken to have the acid strength uniform, the temperature variations slight and the weight of the bauxite charge correct. The analytical work necessary to control the operation of the alum manufacturing plant consists of the analysis of the bauxite, acid and finished product, and the taking of the specific gravity and temperature of the dilute acid before a batch of filter alum is made.

A batch of alum (approximately 7,600 lb.) is made in five mixes, using about one-fifth of the material for each mix, and the time consumed in mixing a batch of alum is about 45 min. Greater speed in mixing and a better mix could have been obtained if a deeper mixing pan with two agitators had been installed. The batch of alum is usually made early in the afternoon and by the next morning the alum cake is ready to be removed from the crystallizing tray. Before the mixture of bauxite and acid is dumped into the tray the fine alum dust remaining in the tray is swept up into a ridge extending directly across the tray and to a height of about 2½ in. When the alum cake is to be

are provided for at Wynyard Square and St. James stations. To facilitate exchange of passengers at the Central and Town Hall stations each island platform is served by a pair of tracks for trains moving in the same direction. Ramps and passages are designed to provide for 30 to 35 passengers per foot of width per minute, stairways for 20 persons up and 20 down at the same rate, and escalators or moving stairways for 10,800 persons per hour.

The new elevated Central Station for suburban trains will have four island platforms and a capacity of 210 trains per hour. The ticket offices will be at the street level, in concourses passing under both ends of the station, with stairways to the platform. The Town Hall station under George St., one of the busiest thoroughfares of Sydney, will have two island platforms reached by stairs and subways. Its capacity will be 140 trains per hour. At Wynyard Square station there will be three island and two side platforms at each level, with a concourse between the two levels and approached by subways from adjacent streets. Its traffic capacity will be 200 trains per hour, including those which terminate at this point.

The Circular Quay station, 70 trains per hour, will have two side platforms 28 ft. above the street and approached by stairs and escalators. At the street level will be the ferry house, ferry offices, parcel check room, stores and a large restaurant. This building will have concrete piers sunk to rock at 20 to 55 ft. below the street surface. The St. James station, with two island platforms, will have a capacity of 130 trains per hour, including the branch trains terminating at this point. Liverpool St. station, with two side platforms will have a capacity of 70 trains per hour.

Construction work on this extensive project was commenced in June, 1916, being carried out by contract under the direction of J. J. C. Bradfield, chief engineer of metropolitan railway construction for the Railway Commissioners. Excavated material was used as filling for the freight terminal and docks at Darling Island, further up the harbor. Work proceeded until June, 1918, when the government considered it advisable to suspend operations temporarily owing to war conditions and the difficulty of obtaining plant and material. The estimated cost is £3,750,000, or about $18,750,000 at normal rate of exchange. This cost is exclusive of the Sydney Harbor cantilever bridge.

Port and Railway Terminal Works at Sydney, Australia

ADDITIONAL railway and harbor facilities for Sydney, New South Wales, are being provided at Darbor, West of the city and at the head of the land-locked bay on which the city is situated. An area of 23 acres at the inner end of Darling Harbor has been reclaimed by filling. Double-deck steel and concrete freight sheds are being built on long piers for ocean steamship service, and will be served by a waterfront railway connecting the city terminals with the freight belt line. At Glebe Island a grain elevator with a storage capacity of 6,500,000 bushels is under construction. In order to keep switching movements clear of the harbor work a freight yard with capacity for 3,000 cars has been built at Rozelle, the junction of the lines to the docks and to the grain elevator.

A freight belt line to serve the harbor was built some time ago owing to the very heavy passenger traffic on the main line. The latter has a general southeast direction to the city. The belt line begins at Rookwood, about 20 miles from Sydney, swinging north in a loop and passing under the main line to run south as far as Enfield, whence it runs east for some distance and then turns north, passing under the main line again at Lewisham and ending at the Rozelle yard mentioned above.

At Enfield is a gravity switching and classification yard with about 40 miles of track and capacity for 4,800 cars, the site being large enough to duplicate the capacity. An engine terminal with roundhouses and coaling station of the American type is established here, and the yard is said to be designed largely in accordance with American practice. A branch from the

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chemists. The work was begun about 1890, earlier work having been done by the American Association for the Advancement of Science. While committees of the American Water Works Association do not co-operate in the preparation of the report, the committees chosen by the other bodies have included members of this organization. Of those who have worked on the preparation of the various editions of the Standard Methods, A. P. H. A., 14 are members of this Association at the present time (list of September, 1919). These are Edward Bartow, J. W. Ellms, George W. Fuller, Allen Hazen, D. D. Jackson, George A. Johnson, E. O. Jordan, H. E. Jordan, W. P. Mason, W. F. Monfort, Earle B. Phelps, R. S. Weston, George C. Whipple, C.-E. A. Winslow. These men are probably the ones most likely to have been selected by this organization for similar work, although it is true that they were chosen and their work accepted by another body and one which is not exclusively concerned with the problem of water supply. It must be remembered, however, that that organization is concerned with sanitation and the protection of the health, rather than with the economics of furnishing water.

Your committee recommends that the Association accept the Fourth Edition of the Standard Methods of Water Analysis (A. P. H. A., 1920) as official.

Your committee recommends that unless at least 100 samples are comprised in the series under consideration, the B. coli index be not reported, and that where an adequate series is considered, the number of samples in the series, together with he dilutions used, be stated. For smaller numbers of samples, some method which does not represent the same degree of fictional accuracy is recommended. A common method of reporting is to express the percentage of positive tubes for each dilution, at the same time giving the number of samples and the number of tubes of each dilution planted. Another common method is the fractional method in which the denominator of a fraction represents the number of tubes planted and the numerator represents the number of positive tubes. Obviously the fraction for each dilution-size is given, together with the number of samples.

On account of its governmental prestige, the United States Treasury Department standard has perhaps been

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A water which is reasonably free from noticeable color, odor, taste and turbidity, which is reasonably free from objectionable salts in solution, which is free from injurious effects upon the human body, and which is produced and distributed in such a manner that its quality is practically certain to be maintained continuously in spite of accidents which can be expected in the operation the plant.

Will Study Low-Carbon Steel Worked at Blue Heat

Work is in progress to determine the effect on the mechanical properties of low-carbon steel, such as boiler plate, of working it at blue heat (300 deg. C.). The effect of low-temperature annealing on such plates will also be determined, and the mechanical properties at elevated temperatures will be measured. Study of the effect of rate of loading will be included in the latter work. For this purpose a motion-picture camera will be used to give records of the simultaneous positions of various moving dials. The Bureau of Standards, Washington, D. C., is carrying on the experiments.

Filter-Alum Making Experience of Montreal Water & Power Co.

Slightly Condensed From a Paper by James O. Meadows, Sanitary Engineer, Montreal Water & Power Co., before the American Water Works, Association, June, 1920.

THE manufacture of filter alum by the above-named company at its filter plant in Montreal, P. Q., is saving the company $24,500 a year. The actual cost per ton, allowing 20 per cent capital charges, is $28.64, compared with $55 for commercial alum. The cost figures are based on the record of the last two years but the general operating data are drawn from an experience of four years.

m plant was installed with the idea of keeping
al outlay as low as possible consistent with
eration, because at the time it was thought
ould only be used for a comparatively short
time. The plant consists of an acid storage
dilute acid tank, bauxite weighing hopper,
mixer, and concrete crystallizing tray. No
s provided, the filter alum being broken up
ble sized lumps by hand sledges. (The plant
r to those at Columbus, Ohio; Springfield,
enton, N. J., and Omaha, Neb.; see *Engineer-*
, Jan. 4 and 11, 1917.)

ying the temperature of the dilute acid the
of the alum can be modified. During the
onths a porous alum is desired because of its
olubility and this product can be obtained by
e bauxite with a low temperature acid. Dur-
alance of the year a filter alum of a more dense
secured by using a higher temperature acid.
erature of the crystallizing tray floor is also
to be considered and it is necessary to use
temperature acid for Monday's batch because
wer temperature of the tray floor after the
est. The temperature of the acid is controlled
ion with compressed air and by a cooling coil
the bottom of the lead-lined dilute acid tank.
the air and cooling coil for different periods
dilute acid of the desired temperature can be

ure a uniform product from day to day care must be taken to have the acid strength uniform, the temperature variations slight and the weight of the bauxite charge correct. The analytical work necessary to control the operation of the alum manufacturing plant consists of the analysis of the bauxite, acid and finished product, and the taking of the specific gravity and temperature of the dilute acid before a batch of filter alum is made.

A batch of alum (approximately 7,600 lb.) is made in five mixes, using about one-fifth of the material for each mix, and the time consumed in mixing a batch of alum is about 45 min. Greater speed in mixing and a better mix could have been obtained if a deeper mixing pan with two agitators had been installed. The batch of alum is usually made early in the afternoon and by the next morning the alum cake is ready to be removed from the crystallizing tray. Before the mixture of bauxite and acid is dumped into the tray the fine alum dust remaining in the tray is swept up into a ridge extending directly across the tray and to a height of about 2½ in. When the alum cake is to be

removed from the tray work is started at the alum dust ridge, as this point offers an easy place to pry the slabs of alum from the tray floor. The alum cake is removed from the floor with bars and picks and is broken up with hand sledges. The whole process, including carting to the storage floor above, consuming about six hours.

Records of the alum-making plant for the two years ending May 1, 1920, are presented here, as during this period the cost of bauxite and acid have been rather constant and it was thought that data covering this period would be fairly representative of present conditions. The cost of production for this two-year period is as follows: Bauxite and acid, including freight and cartage, $45,961; wages, $4,220; maintenance, $1,490; interest and depreciation, 20 per cent, $2,400; total, $54,071. During these two years 1,888 tons of filter alum have been produced, making the cost $28.64 per ton. The market price of commercial filter alum (including freight and duty) during this period has been about $55 f.o.b. Montreal and based on this figure the alum making plant has shown a saving of slightly more than $49,000 for the two years. Bauxite cost approximately $24 per ton and 66 deg. Baume sulphuric acid, $26 per ton. The cost of bauxite and acid makes up 85 per cent of the total cost.

In the manufacturing of filter alum at the point of consumption, freight, bagging and cartage is saved on the water, which makes up about 20 per cent of the finished product. Experience over a considerable period has shown that the weight of the filter alum produced is practically the same as the combined weight of the materials that go to make up the products.

At the company's water purification plant the alum solution is pumped to the orifice box and from this point flows by gravity to the point of discharge. Since Hoover process filter alum has been used greater depreciation of the solution pumps, valves, and fittings has taken place, due to the nature of the insoluble matter contained in the alum solution. This depreciation has not been excessive.

The manufacture of Hoover process filter alum has proved successful for the Montreal Water & Power Co. not only because of the saving effected but also because less storage space is required than for commercial alum. The sulphuric acid is produced within a short radius of Montreal and is easily obtainable. This leaves only the bauxite to be secured from a distance. Each ton of bauxite in storage represents about three tons of the finished product.

Timber From Live and Dead Trees

Prejudice exists in certain quarters against the use of timber cut from dead trees, and some purchase specifications insist that only timber cut from live trees will be acceptable. As a matter of fact when sound dead trees are sawed into lumber, and the weathered or charred outside is cut away, there is no method known to the U. S. Forest Products Laboratory by which the lumber can be distinguished from that cut from live trees, except that the lumber from dead trees may be partly seasoned when sawed. All the information available at the laboratory indicates that timber cut from insect or fire killed trees is just as good for any structural purpose as that cut from live trees of similar quality, providing the wood has not been subsequently injured by decay or further insect attack.

Geology of New York City Revealed in Core Boring Exhibit

Records of 2,000 Holes, Illustrative Maps, Models, Complete Core Sample Collection Form Exhibit in Municipal Building

By M. E. Zipser

Chairman, Committee on Preservation of Core Boring Records, Municipal Engineers of the City of New York

NOT all engineers realize the importance and value of thorough exploratory investigations in engineering projects. In designing the foundations of large buildings and bridges, and in planning the construction of tunnels, subways, sewers and other subsurface structures, a knowledge of the geologic conditions to be encountered is essential if the work is to be carried out safely, efficiently and economically. There are many cases on record where, owing to failure to make an adequate investigation of underground conditions, the work resulted either disastrously or necessitated modifications in plan involving a large increase in cost. There are other instances where, although considerable effort and expense were incurred in making borings, the results were not successful owing either to unintelligent planning of exploratory work, or to improper methods adopted, or to failure of proper interpretation of the materials and data obtained by the borings. Engineers are, therefore, beginning to appreciate more and more the value of the services of a competent consulting geologist in engineering enterprises.

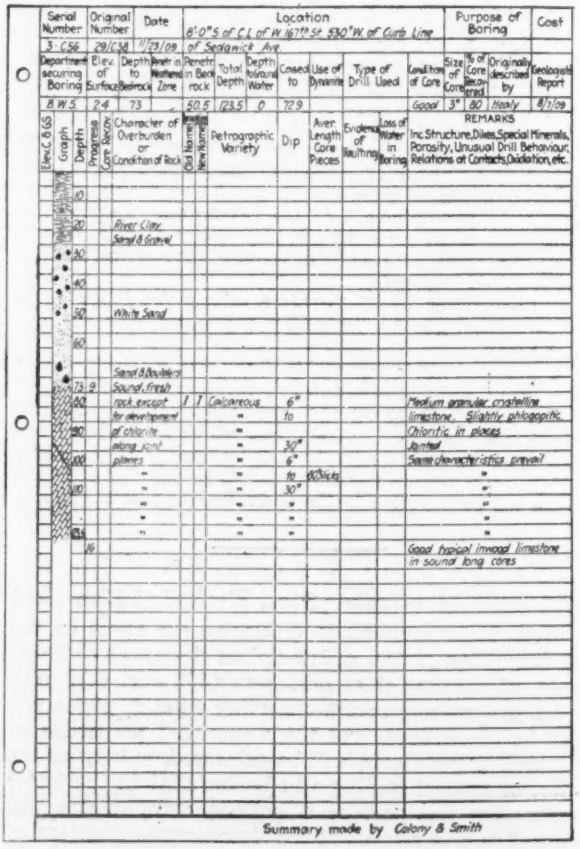


FIG. 1. COMPLETE DATA ON 2,000 HOLES AS SHOWN HERE ARE AVAILABLE

In New York City, the underground conditions present many difficulties to the designer and constructor. The depth to bed rock varies considerably. In the northern portion of the city the rock in many places lies at the surface. Below Thirtieth Street there are no outcrops and the depth to rock increases as the southerly limit of the city is approached, there being as much as 200 ft. of drift in spots. The nature of the material overlying the rock varies in character. Deposits of boulder, clay and sand are distributed unevenly throughout the city and silt is found beneath the river. The city is underlain by five different rock formations, each varying in quality and having different characteristics. The rocks have been subjected to extensive folding and faulting, resulting in the formation of crush zones and weak belts in several places. At Morningside Park and on the lower East Side, for example, decayed rock more than 150 ft. in depth has been revealed by borings in connection with the city tunnel of the Catskill Aqueduct.

Many Exploratory Borings Made

On account of the complex geology of the city, it has been necessary to make many exploratory investigations of the underground conditions in connection with the many public and private engineering undertakings. There have been thousands of borings made in New York City, at an expense estimated at $3,000,000. Unfortunately, the records obtained from a great many of these borings have, in many cases, been lost or they were destroyed when the purpose for which they were made was served. In other cases, records have not been properly preserved or interpreted and have not been readily available. Some time ago the Municipal Engineers of the City of New York realized that the assembling of all the available data and records relating to borings in New York City, including the preservation of the cores, would serve a very useful purpose in avoiding much exploratory expense in future undertakings by city departments, and in making easily available all existing information in regard to underground conditions. A special committee, under the chairmanship of James F. Sanborn, was appointed for this purpose. The committee, under the direction of Dr. Charles P. Berkey, Professor of Geology, Columbia University, as consulting geologist, has investigated and assembled all the available data bearing on borings and explorations in New York City and the records have been arranged for preservation in permanent form. The work has been supported by the city through the Board of Estimate and Apportionment. The collection of records is housed on the 34th floor of the Municipal Building. The principal parts of the collection and exhibit are:

1. **A complete tabulation of records of core borings in New York City.**
2. **A series of maps showing the locations of these borings and also the rock floor conditions.**
3. **A collection of representative rock cores, illustrating the rock formations of the city and the conditions encountered underground.**

Every core boring in the city that has been available or whose record is considered at all reliable, has been investigated and the facts have been entered upon a regular standard form of record, adopted for this purpose—a separate 8½ x 11-in. sheet. This sheet, one of which is herewith reproduced, carries the record of each boring with all the available data recorded. Approximately 2,000 of these separate boring records are now on file. Records are grouped into series corresponding with the different city departments or the private enterprise or undertaking re-

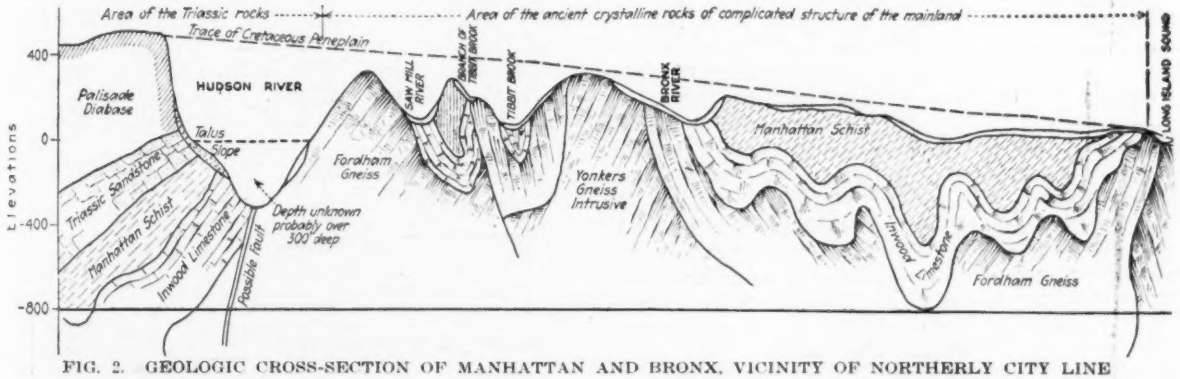


FIG. 2. GEOLOGIC CROSS-SECTION OF MANHATTAN AND BRONX, VICINITY OF NORTHERLY CITY LINE

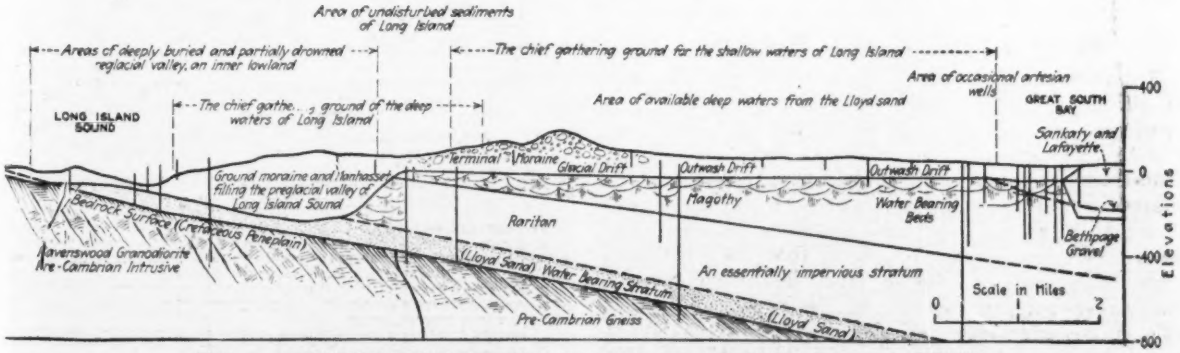


FIG. 3. GEOLOGIC CROSS-SECTION OF LONG ISLAND, VICINITY OF BABYLON

sponsible for the original investigation. The collection of core boring samples includes 570 pieces of core, each labeled as to rock type and variety, and the formation to which it belongs.

In order to find the geologic data of any particular location of the City, inspection is made of an index map, which is a large wall map of New York City, on which have been placed red circles, indicating the approximate locations of the holes whose records are in the collection. The index map is divided into quadrangles or sectional plans numbered from 1 to 35. Having noted the sectional plan number on which the particular borings in question are located, reference is made to the large scale sectional plans on which are shown the exact locations of the borings, each boring having a designation, as C 73, the letter indicating the series in the collection, and the number the succession in the series. By referring to the volume containing the the separate sheets of any series the history of any particular hole is quickly found.

There are also included in the exhibit a relief model and block diagram showing the geologic structure of the city. Many special illustrated photographs, drawings and charts are also shown, and there is a collection of reports, special papers and other references bearing upon the geologic conditions in the engineering undertakings of New York City. Copies of contracts and specifications for borings and relative data are also on file. Sample boxes containing core and loose materials, showing improved methods for preserving boring samples are also on exhibit.

To anyone interested in the underground conditions of New York City, either from the point of view of the geologist or from the standpoint of the engineer or contractor wishing to know the depth to bed rock at any point, or the character of the material overlying the rock, or the nature and condition of the rock, the collection and exhibit will be found very useful. Permission to see the exhibit and consult the records may be obtained by those interested at the office of Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, Room 1347, Municipal Building. The Committee on the Preservation of Core Boring Records of the Municipal Engineers wishes to make a plea to engineers and contractor to bring to the attention of the committee any information bearing on the geology of New York City and vicinity that may be revealed by borings and excavations, in order that the collection and records may be made more complete and more useful.

How Lumber Is Graded

Grading of lumber is done under a multiplicity of grading rules. H. S. Betts, engineer in forest products, Forest Service, U. S. Department of Agriculture, tells how lumber is graded in a 40-page, 6 x 9-in. pamphlet, *Bulletin* 64, on the subject. Woods are graded largely according to rules prepared by lumber associations, the members of which handle lumber of one or more species that grow in a certain region or are naturally grouped together, with the exception of the hardwoods, which are all graded according to the rules laid down by the National Hardwood Lumber Association, having headquarters in Chicago. Soft woods, on the other hand, are graded according to rules promulgated by more than 16 associations. The bulletin mentioned gives the basic data for the principal rulings.

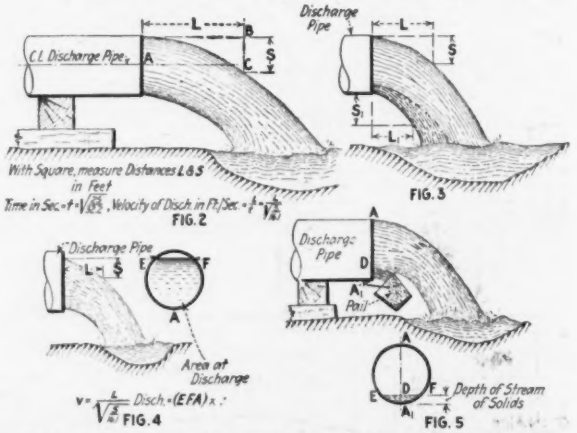
Measuring Velocity of Discharge From Hydraulic Dredge Pipes

By Pierce J. McAuliffe
Consulting Engineer, New York City

KNOWLEDGE of the performance of hydraulic dredging equipment is commonly deficient because velocity and quantity of discharge are not known. For this reason there is not as close check on operating conditions, so that best results can not be secured. By use of the simple field method of measuring discharge velocity described in the following, data can be secured that should make dredge pumping subject to the same control of performance as other working plant.

The merits of the dredging pump as a device for excavating and conveying earth, gravel and minerals are widely known, but this machine would be applied to a greater range of activities if the laws governing friction and velocity in dredging pipes were better understood. There are few published data of value, however, to show the velocities required in pipe lines to keep different percentages of solid materials in suspension in the stream of water, and to enlighten us as to the friction that will be caused by these mixtures at the various velocities. It is not surprising that installations of dredging pumps have been made occasionally in which sufficient power or peripheral speed or both have not been provided to produce the velocity necessary in the discharge. Because such installations have been unsatisfactory the machine as a class has frequently been blamed, and as a result artificial limitations have been built up around the dredging pump.

There is an infinite number of combinations of materials that a dredging pump is called upon to mix with water and push through a pipe line; solids ranging all the way from river silt (which may create less friction than water alone) to materials of high specific gravity and irregular shapes, such as coarse granite gravel (which causes the friction to build up to several times that set up by water alone). It is not difficult, therefore, to understand the hesitation on the part of the



FIGS. 2 TO 5. DISCHARGE VELOCITY MEASUREMENT UNDER DIFFERENT CONDITIONS

To measure discharge of solids, proceed as follows (Fig. 6):
1. Push a rule down through water from A until steam of solids in lower sector is plainly felt. Subtracting this depth from the diameter gives depth of stream of solids.
2. Determine velocity in lower sector.
3. Area of lower sector EFA_2, multiplied by velocity gives discharge from lower sector.
4. Catch discharge from lower sector in pail as shown.
5. Measure percentage of solids in contents of pail.
6. Quantity of solids discharged per second = Item 5 × Item 3

engineer to publish data, which, though they may serve for his individual use, depend largely for their value upon his personal inspection of the materials to be handled.

An important step toward securing reliable data on friction and velocities in dredging pipes will be taken if we discover a simple and readily applied method of determining the velocity of the discharge. The friction can be found quickly from the readings of the pipe-line pressure gages, which are a part of the equipment of practically all dredging pumps. The difficulty has been to say what was the velocity of the discharge and what were the relative quantities of water and solids in the discharge at the time these gage readings were taken.

A number of ingenious tests have been made to determine the velocity of discharge in dredging pipes when pumping water only. But as the meters used or the methods employed in determining the velocity are not applicable when solids are carried in suspension, the data, while useful in calculating the efficiency of the machine when pumping water, are only indirectly helpful in predicting what will happen when the discharge stream is carrying dredged material. Still it is on such tests that the designers of dredging pumps have had to rely to a large extent for guidance.

How widely the discharges may differ under these two conditions is shown by the views *A* and *B* of Fig. 1 both picturing the discharge from the 16-in. Kaw Valley Drainage Board dredge. View *A* was taken while the suction was raised from the bottom of the river, consequently only water was being pumped; *B* was taken with practically the same length of pipeline, the same pipeline elevation and the same peripheral speed of the pump impeller, but the dredge was digging in the regular manner.

Suppose it had been found that the velocity in *A* had been 18 ft. per sec. and that operating as in *B* for an extended period an average of 250 cu.yd. per hour had been delivered, with the same power and peripheral speed that had been required in *A*, a relation between these qualities would have been obtained to guide us in future designs. This might be called a *post factum* procedure, but designers have had to rely for guidance largely upon such methods for getting data.

To make up for the lack of information which was necessary for the intelligent design of dredging pumps and to compile data from personal observations, the writer has for some time used a very simple method for finding the approximate velocity of the discharge, and therefore the quantity of the mixture, passing through a pipe line. Reference to accompanying sketch, Fig. 2, will assist in understanding the method. It is based on two assumptions: (1) That the discharge curve will have a definite form for each velocity through the pipe: (2) That but two forces act upon each particle in the discharge as it leaves the pipe, these being the pressure developed by the pump (converted into uniform horizontal velocity), and the force of gravity causing each particle to become a freely falling body.

In applying this method the end length of the discharge pipe should be approximately level. With a straightedge or square measure the horizontal and vertical co-ordinates of any point on the curve *C* in Fig. 2, reading both *L* and *S* in feet. The time that it has taken a particle at *A* to fall the vertical distance

FIG. 1. DISCHARGE OF 16-IN. DREDGE WHEN PUMPING WATER AND WHEN DIGGING

or S can then be found by the formula $S = \frac{1}{2} gt^2$, or $\sqrt{\frac{2S}{g}} = t$, in which t will be the time in seconds. Similarly the horizontal distance that the velocity has carried a particle during time t will be L. Dividing L, the horizontal distance, by t, the time of travel, gives the horizontal velocity of the mixture.

Fig. 6 shows the application of the writer's method to the discharge from a 6-in. pipe. It will be observed that the device used to measure the co-ordinates of the point C on the upper curve AC was an improvised carpenter's square, the vertical leg S of which was equal to the thickness of the pipe plus 6 in., or 516 ft. The length L was found to be 3.166 ft. Applying the formula as in Fig. 2, V becomes 17.7 ft. per sec. A Venturi meter connected to this pipe when this picture was taken registered a velocity of 16.5 ft. per sec. The writer's method, therefore, indicated a velocity about 7 per cent higher than actual velocity. A close inspection of the view reveals that the leg S intercepted only the spray of the discharge. A more careful adjustment would have given a value of 3.08 ft. to L and the answer would then have been 17.4 ft. per sec. or about 5 per cent in excess of the actual velocity. This photograph is one of a series taken during tests made by the Morris Machine Works of Baldwinsville, N. Y. Other tests of the series gave results less than 2 per cent in excess.

In such tests as the writer has had an opportunity to make, the velocity indicated by the upper curve is nearer the actual velocity than is the mean of the upper and lower.

It is usually such a simple matter to pry up the end length of a dredging pipe to a level position that it is not considered worth while at this time to enter into a discussion of the modifications in these calculations that would be necessary for pipes out of level.

Special Conditions.—Fig. 3 represents a condition frequently met with in dredging, where the material has separated from the water and is traveling in the lower part of the pipe at a lower velocity than that of the water. In cases of this kind, where the difference in velocity of water and material is not too marked it is satisfactory to measure the velocity of the upper and lower curves of the discharge and use the mean as the velocity of the mixture.

Fig. 4 shows a condition where the discharge does not completely fill the pipe at the end. In this case the particles in the upper part of the stream will have a slight initial velocity downward by the time they

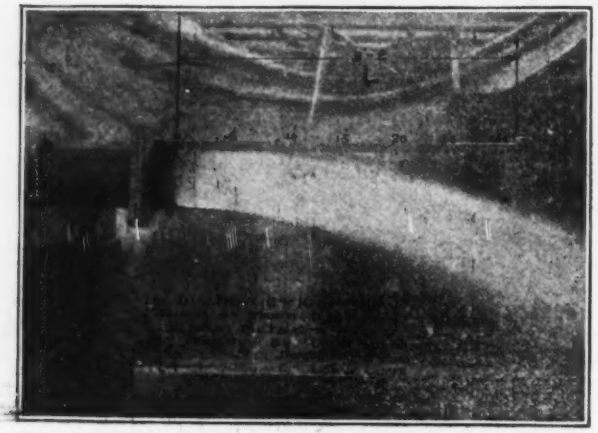


FIG. 6. VELOCITY MEASUREMENT WITH 6-IN. DISCHARGE

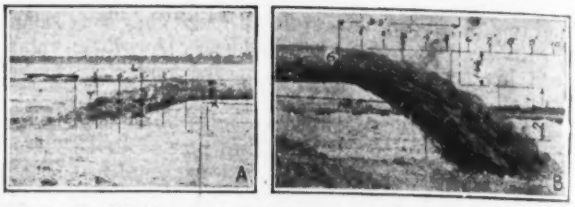


FIG. 7. MEASURING DISCHARGE VELOCITIES FROM PHOTOGRAPHS

are about to leave the pipe, but under ordinary dredging conditions the velocity reading will be sufficiently accurate if the procedure in Fig. 4 is followed.

Where the material has separated and is traveling in the lower sector of the pipe (Fig. 5) the writer has found it convenient to approximate the quantity of solids that is being moved through the pipe by measuring the distance from A down to the surface of the almost solid stream of sand or stone (indicated at D) and then determining the area of the sector that is filled with materials. When the lower end of the rule used to measure AD, touches this body of moving sand it can be felt distinctly. By measuring the velocity of the lower curve of the discharge, the velocity at which the stream of solids is moving can be estimated. The quantity of solids that is being handled can be approximated to a reasonable degree of accuracy from these figures for velocity and area. The water content and mechanical makeup of the stream of solids may be determined from a pail sample.

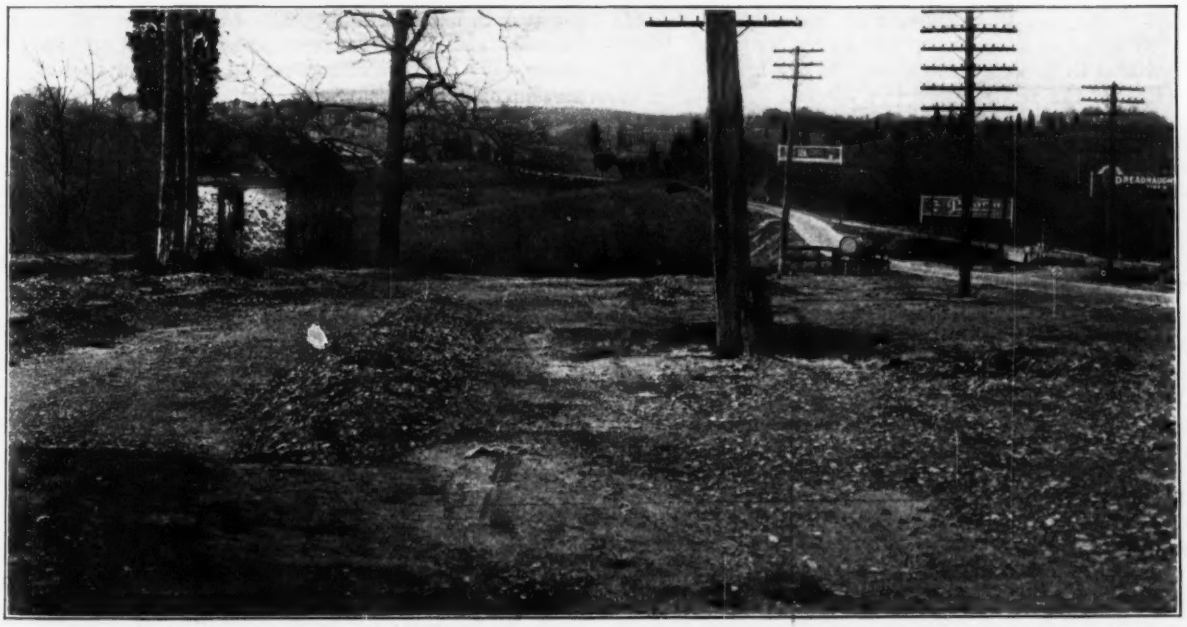
All wide-awake dredging contractors require daily reports from their dredge operators. These reports are of value to show what has been accomplished, but they could be made of far greater value as a guide to the performance on future work if they contained a statement to show the velocity at which the pump pushed the mixture through the discharge pipes, and the friction which resulted from this velocity and mixture. With this information the contractor could tell definitely what his machine would do on longer pipe lines when they would be encountered, and in many cases he would be warned sufficiently in advance that a booster would be required to prevent the job from showing a loss.

While the calculations involved in this method are quite elementary, few dredge operators have been equipped to make them. To permit of frequent readings the writer has supplied a number of operators with devices similar to that shown in Fig. 7, calibrated so that the velocity may be read directly.

A further advantage is that a photograph of a pipe discharge becomes of considerable value (Figs. 7 A and B). Extend the lower line of the pipe shown in A until it intersects the upper curve of the discharge at Y. This discharge was from one of the 10-in. dredging pumps which the Michigan Limestone & Chemical Co. used for the disposal of the overburden and for the storage of the small sized screenings from its huge rock crushing plant at Calcite Mich. At Y the upper curve has therefore fallen 0.869 ft., this being the diameter plus the thickness of the pipe. Measuring the horizontal co-ordinate of Y in pipe diameters gives a value of 5 ft. to L and indicates a velocity between 21 and 22 ft. per second.

View B of Fig. 7 shows the 20-in. discharge pipe of the dredge "St. Louis". By the same method as described above the velocity is found to be between 15 and 17 ft. per second.

Relocation of Deadman's Curve, Washington Road Between Baltimore and Washington, D. C., by Maryland Commission



The State Roads Commission of Maryland eliminated this Curve at a cost of $17,000. The upper picture is a view looking north and the lower one looking south. As originally built the road was responsible in ten years for accidents resulting in thirty deaths. John N. Mackall, chief engineer of the State Roads Commission, points out that this is the first instance of expensive construction to abolish dangerous features on main highways.

Wind Loads on Miscellaneous Structures

Wind Pressure To Be Assumed on Billboards, Sky Signs, Fences and Walls, Traveling Cranes, Flags and Flag Poles—Code Provisions and Practical Recommendations

By R. Fleming
American Bridge Co., New York City

OCCASIONALLY the engineer meets with problems of wind loads on structures other than those coming under the classification of bridges, buildings, tanks or towers. The question as to the proper amount of wind pressure to be assumed on some of these occasionally-met-with structures will be considered in this article.

Billboards

According to the Cleveland building code,

The term bill-board within the meaning of this ordinance shall include all structures, of whatever material the same may be constructed, which are erected, maintained or used for the public display of posters, painted signs, pictures or other pictorial or reading matter, except that the term "bill-board" shall not be applied to such signs as are attached to the roofs or walls of buildings.

The only external force acting on a billboard is the wind, but although the literature about the billboard is extensive comparatively little information is given on the proper wind pressure to be assumed in its design. Probably the most comprehensive review of the subjects of billboards and sky signs is the "Report of the Mayor's Billboard Advertising Commission of the City of New York," a book of 152 pages, dated Aug. 1, 1913. At that time there were about 4,600 facings or 90 acres of advertising surface in the city. Large additions have been made since. In the Proposed Ordinances of the report there is a clause,

No structure subject to regulation by paragraph (1) of this section, which shall at any point exceed 7 ft. in height above the ground immediately below it, if erected upon the ground, and no such structure whatever erected upon a roof . . . shall be erected or maintained unless it shall be designed and constructed in such manner as to sustain a wind pressure of at least 40 lb. per sq.ft.

This recommendation was never enacted into law. Quite in contrast with the drastic recommendation of the New York report is the provision of the "Model Billboard Ordinance" given in the August, 1917, issue of *Pacific Municipalities:*

Every billboard having an advertising surface of more than 20 sq.ft. shall be made to withstand a lateral wind pressure of 20 lb. per sq.ft.

In their respective ordinances San Francisco specifies 20 lb. per sq.ft. wind pressure; Chicago, 25 lb.; Cleveland, Indianapolis and Seattle, 30 lb.; Milwaukee and Omaha, 40 lb.

The writer considers 20 lb. per sq.ft. wind pressure on the exposed surface of billboards to be ample. The reason for a greater pressure being prescribed in some ordinances is the desire to protect passers-by. But 20 lb. pressure means a velocity of about 70 miles per hour and no pedestrian can stay on the street during such a wind. A man weighing 150 lb. presents about 8 sq.ft. of surface to the wind, with a centroid about 3.5 ft. from the ground; when he braces himself with one foot 2.5 ft. ahead of the other he can withstand a pressure of $\left(\frac{150 \times 2.5}{8 \times 3.5}\right) = 13.4$ lb. per sq.ft., and with a pressure of 20 lb. per sq.ft. he can not keep his feet.

In the words of the building code recommended by the National Board of Fire Underwriters, any letter, word, model, sign, device or representation in the nature of an advertisement, announcement or direction, supported wholly or in part over or above any wall, building or structure, is called a sky-sign.

Sky Signs

The sky sign is so closely related to the billboard that it might seem the same pressure should be used for both. However, the sky sign is usually in a more exposed location than the billboard. Again, the velocity of the wind and consequently the wind pressure increase with the distance from the ground. For these reasons building codes assign a greater wind pressure to sky signs than to billboards.

The code of New York City allows metal signs to extend up to 75 ft. above the roof of fireproof buildings, but limits the portions of such signs covered and exposed to wind pressure to 35 per cent of the total area. Wind pressure is specified at not less than 30 lb. per sq.ft. The Chicago ordinance limits height to 60 ft., surface exposed to 50 per cent of frame area, and wind pressure to not less than 30 lb. Augusta, Detroit, Minneapolis and Rochester also specify 30 lb. pressure, under varying regulations regarding height and proportion of exposed surface. Indianapolis restricts the height to 40 ft., the surface exposed to 40 per cent and wind pressure to not less than 35 lb. Seattle limits height to 45 ft. and surface exposed to 50 per cent, and specifies wind pressure at not less than 40 lb. The Spokane code calls for a wind pressure of 40 lb. but is silent on height and percentage of exposed surface.

The writer would restrict the height of sky signs to 60 ft., the surface exposed to 50 per cent frame area and assume wind pressure at not less than 25 lb. per sq.ft. of exposed surface when the sign is on buildings 6 stories high and less, and 30 lb. when on buildings more than 6 stories high. The stresses in members of the steel frame of the building due to wind on the sky sign should be added to other stresses. This is not always done; sky signs are often erected upon the roofs of existing buildings with but little examination of the strength of supporting members.

In proportioning sky signs the Chicago rule may safely be followed:

For stress produced by wind forces combined with those from live and dead load, the unit stress may be increased 50 per cent over those given above, but the section shall not be less than required if wind forces be neglected.

Fences and Walls

A Chicago building ordinance limits the height of fences and walls to 8 ft. if constructed alongside a street or alley or within 8 ft. of such street or alley and parallel thereto. The ordinance continues:

No single or isolated wall of any material whatever,

which forms no part of a building or structure that may be lawfully erected, shall be constructed upon any portion of a lot where the distance from such wall to the lot line is less than the height of the wall, unless such isolated wall shall have lateral supports on at least one side of same with braces extending to the top of the wall and is so constructed that it shall be capable of resisting a horizontal wind pressure on every part of same twice as great as buildings under the provision of this chapter must be designed to resist.

The wind pressure specified in the Chicago Code for buildings is 20 lb. per sq.ft. of exposed surface. Walls similar to the foregoing are therefore required to withstand 40 lb. per sq.ft. This is excessive. Isolated walls usually stand by virtue of the moment of stability of their own weight. A 12-in. wall 8 ft. high built of brick weighing 120 lb. per cu.ft. would be blown down at a pressure exceeding $\left(\frac{8 \times 120 \times 0.5}{8 \times 4}\right) =$ 15 lb. per sq.ft. A 12-in. wall 7 ft. high would be blown down at a pressure exceeding $\left(\frac{7 \times 120 \times 0.5}{7 \times 3.5}\right) =$ 17.1 lb. per sq.ft. An 8-in. wall 6 ft. high would be blown down at a pressure exceeding $\left(\frac{6 \times 80 \times 0.33}{6 \times 3}\right) =$ 9 lb. per sq.ft. Walls of these heights and thicknesses are quite common and do not blow down. The writer thinks that an assumed wind pressure of 20 lb. per sq.ft. is sufficient. Because walls may become defective with age there should be added to this assumption the provision that the overturning moment due to wind pressure shall not exceed two-thirds of the moment of stability.

With this provision a brick wall if 8 ft. high should be not less than 17 in. thick; if 7 ft. high not less than 15.9 in. thick, and if 6 ft. high not less than 12.7 in. thick.

Sides of Buildings

More than a score of buildings codes have the provision:

Every panel in a curtain wall shall be proportioned to resist a wind pressure of 30 lb. per sq.ft.

How shall it be determined whether or not a given panel fulfills this provision?

Tests to determine the strength of hollow tile for building walls were made in 1914 under the direction of Professor Van Ornum of Washington University, St. Louis (a synopsis of the tests is given in the *Engineering News*, Vol. 73, p. 428, March 4, 1915. Through the courtesy of The Laclede-Christy Clay Products Company the writer is enabled to quote from the original report).

Pressure was gradually applied by a hydraulic jack with a broad base to the middle of a 13-in. brick wall 10 ft. by 10 ft. laid in *lime* mortar bonded at the top to a concrete slab and at the bottom to a concrete footing. When a pressure of 2,500 lb. was reached the horizontal mortar joint at about half height opened for its full length on the tension face. A 12-in. wall of Denison interlocking tile of the same dimensions laid in *cement* mortar failed in like manner at a pressure of 5,000 lb. A "wind pressure test" was made on two parallel tile walls laid in cement mortar. The walls were 14 ft. long by 21½ ft. high, 7 ft. 10 in. apart out to out, and were joined by a line of wooden joists at a height of 9½ ft. above the footing and by another line at the top. At an average uniform pressure of 14⅜ lb. per sq.ft. on each wall, horizontal tension cracks showed themselves in the mortar joints near the base.

This test was made for a specific purpose and too general conclusions can not be drawn from it. Yet, quoting from Professor Van Ornum's report,

It is neither a simple matter, nor entirely satisfactory, to attempt to reason from the conditions and results of this experiment to the practical stability that the same walls would have shown if they had had the support (which masonry walls in actual structures always have) of continuous walls or partitions, or both, extending transversely between them. There is no possible doubt that the resistance would have been many times as great; . . . Brick walls would have furnished about 2¾ times as great a resistance to overturning, due mainly to their greater weight. But because the lime mortar of the ordinary brick wall has a strength averaging only one-sixth to one-tenth that of Portland cement mortar as used with the tile, the aggregate resistance that would have been recorded if they had been 13-in. brick walls, instead of 12-in. tile, would probably have been not far from the same.

Window sash and glazing form an important part in the side of a modern building. This is especially true of the steel sash used so largely for industrial buildings. The writer has been given the details of a test made by a firm of engineers. The largest standard unit of steel sash, about 6 by 12 ft., of 14 by 20 in. lights, 5 lights wide by 7 lights high, was laid flat with its 4 edges resting on a solid frame. It was then covered with sheet metal and uniformly loaded with sand. At a load of 18.2 lb. per sq.ft. the maximum deflection was $\frac{3}{4}$ in. At a load of 25.4 lb. per sq.ft. the maximum deflection was $\frac{11}{16}$ in. When the load was removed the permanent deflection was $\frac{3}{32}$ in.

The tests cited—the only ones available to the writer—are not sufficient to warrant any positive statement as to the wind-resistive strength of a panel in a curtain wall. The New York building code specifies that masonry walls supported at each story by girders may be 12 in. thick for the entire height of the building. This practice is followed by 40 or 50 cities. Other cities increase or decrease the thickness of the wall, making it depend upon the height and width of the panel. So few, if any, failures of curtain walls are recorded that present practice is justified by its results.

Traveling Cranes

The traveling crane is closely related to bridges, towers and similar structures with respect to intensity of wind pressure and the area on which it acts. The "Code of Safety Standards for Cranes" of the American Society of Mechanical Engineers specifies:

Calculations for wind pressure on outside cranes shall be based on not less than 30 lb. per sq.ft. of exposed surface.

The same clause is found in "General Requirements for Safety" (1918), U. S. Steel Corporation.

It is noted that nothing is said as to what shall be taken as the area of exposed surface. The writer recommends that for outdoor traveling cranes a wind pressure be assumed of 30 lb. per sq.ft. on the entire projected area of the windward truss plus one half the projected area of the leeward truss. When plate girders are used in pairs not farther apart than 1½ times the depth of the girder, the projected area of only one girder need be considered.

Care should be taken that traveling cranes, when not in use, are sufficiently anchored to prevent their being moved by wind pressure. Several cranes have been wrecked from being set in motion because the fastenings gave way during a strong wind.

Crane makers do not usually specify working stresses. Two large makers have in their specifications the respective sentences "Factor of safety not less than 5 in all parts of the crane" and "The crane will be designed throughout to have a minimum factor of safety of five when under full load." Some government specifications require that live loads be increased 20 per cent for impact and specify working stresses of 16,000 lb. per sq.in. for tension and 16,000—70 l/r for compression, with the provision that for bracing and combined stresses due to eccentric loading the permissible working stresses may be increased 25 per cent.

The writer recommends that outdoor traveling cranes be proportioned for working stresses of 16,000 lb. tension and 16,000 — 70 l/r compression for combined dead and live load (plus 25 per cent impact). When combined with wind load these working stresses may be increased 25 per cent.

Wind loads and stresses for gantry cranes and coal or ore handling bridges are more troublesome. These structures are often of considerable height and span. Sometimes they are in locations exposed to unusually severe winds. The problem before their builders is two-fold: first, to make them light enough to require a minimum amount of power to move them and second, to make them strong enough to carry the required loads and resist any probable wind. Coal and ore handling bridges have been wrecked by wind. A storm at Superior, Wis., May 25, 1914, destroyed the largest coal handling bridge in the world: a span of 552 ft. with a height of 140 ft. from rail to top chord. It would have been interesting to determine from working drawings the wind force necessary to blow over this and other traveling bridges that have met a like fate.

A number of gantry-type yard cranes recently constructed for a shipbuilding company afford an illustration of the complexity of requirements often presented by outdoor cranes, and assumptions made in the design that appear to the writer to be commendable. The gallows frames consist of two A-towers each on two trucks 50 ft. apart and running on a single rail. The rails are 89 ft. center to center. The overhead connecting part consists of two plate girders 8 ft. deep and 12 ft. apart on centers and overhanging 29 ft. at each end, thus being 147 ft. long from end to end. A rail the full length of each girder provides a runway for two hammerhead-shaped traveling towers with a trolley arm 45 ft. and counterbalance arm 22 ft. 9 in. long. Each tower has a truntable base enabling it to revolve through a complete circle. The height of towers is 23 ft., thus making a height of 102 ft. from ground rail to top of towers.

Wind pressures as follows were assumed on the steel frame of the gantry: For wind blowing in a direction parallel to the ground track, 30 lb. per sq.ft. on the surface of the windward girder and tower legs plus one-half the surface of the leeward girder and tower legs; for wind blowing in a direction at right angles to the ground track, 30 lb. per sq.ft. on the projected area of each tower plus one-half the projected area of all the cross frames between the girders. In combining wind loads with dead-plus-live loads, 10 lb. per sq.ft. was used instead of 30 lb., as it is unlikely that the cranes will be in operation during a wind blowing at more than 50 miles per hour (equivalent to a pressure of 10 lb. per sq.ft.). To the wind loads on the gantry were added those on the towers. These were given by the builders of the towers, for each tower, as 12,000 lb. and 5,000 lb. respectively for wind at right angles to and parallel with the arms. These loads were used in combining wind loads with both dead and dead-plus-live loads. They are moving loads and were considered for any location of the towers on their track and for any position of either tower on its turntable base.

The working stresses used were 12,000 lb. per sq.in. tension for combined live and dead loads and 15,000 lb. per sq.in. tension for wind plus dead and wind plus dead plus live loads. Compressive stresses were taken at 10,000 and 12,500 lb. per sq.in.

Flags and Flag Poles

The Bureau of Yards and Docks, U. S. Navy, made tests in 1916 to determine the pull of flags due to wind. The results showed that the total horizontal resistance of a flag exposed to a steady current of air can be approximately represented by the formula: $R = CAV^{1.8}$, where R is resistance in pounds, A is area in square feet, V is velocity of wind in miles per hour, and C is a constant equal to 0.0003. For convenience the equation may be written $R = 0.0003AV^2$. This is about one-twelfth ordinary normal pressure. Assuming a velocity of 100 miles per hour, the value of R is 3 lb. per square foot of flag area.

The Building Code of the City of Seattle has a section reading:

> Every flag pole . . . shall be so braced, supported or stayed as to be capable of withstanding a computed wind pressure of 100 lb. per sq.ft. of pole surface.

Whatever is meant by "square foot of pole surface," the requirement is unreasonable. It was probably the compiler's intention to assume a pressure on the pole large enough to include that on the flag, but this is illogical. A wind pressure of 25 lb. per sq.ft. on the vertical projection of the pole and 3 lb. per sq.ft. on the area of the flag is sufficient.

Railway Tunnel for Postal Service To Be Built in London

A 9-ft. tunnel about 6½ miles long for carrying automatic railway trains to transport mail is about to be built in London, bids having just been called for. Plans were developed some years ago, and in fact the operating system was worked out by the help of an experimental line reproducing both grades and curves of the proposed railway. The tunnel is to extend from the Paddington District post office to the Whitechapel post office. It is to carry two tracks of 24-in. gage, and the trains operating on these tracks are to be handled by remote control. On account of the necessity of avoiding other tunnels and subsurface structures, the depth of the tunnel below ground surface will vary from 28 to 87 ft. At stations, says *The Engineer* of London, from which this information is taken, the tracks are to be separated about 20 ft., to accommodate elevators and mail chutes between them.

Combined Deferrization, Softening and Filtration Plant

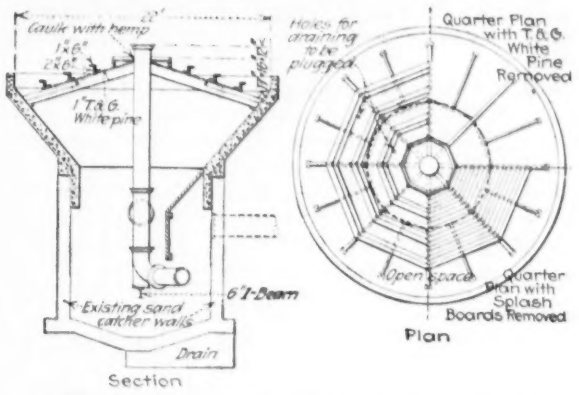
Permanent Plant at Camp Funston Treats Well Water Fully in Winter, but Removes Iron Only in Summer—Has Film Aërator

By Webster L. Benham

Of Johnson & Benham, Consulting Engineers, New York and Kansas City; formerly Utilities Officer and Constructing Quartermaster, Camp Funston, Kan.

THE WATER SUPPLY for Camp Funston, Kan., which is located on the military reservation of Fort Riley, is obtained from eight 24-in. wells, 40 ft. to 72 ft. deep. Although the water is clear and colorless, it has a large iron content, ranging from 3 to 5 p.p.m., and an alkalinity of about 300 p.p.m. The permanent hardness, which ranges from 30 to 50 p.p.m., is relatively low. The water contains a low number of bacteria even for a well water. All counts have been made on agar which would probably indicate a number somewhat lower than counts made on gelatine. Occasionally the number is high and at rare intervals intestinal bacteria have been found.

The hardness caused excessive formation of scale in the boilers at the camp, thus entailing considerable power losses and trouble. The camp had 17 central heating plants and, as there was no return system, water of condensation was not returned to the boilers, with the result that there was wasted during the winter months 500,000 gal. per day. Continual cleaning of the boilers and heaters was necessary. A great deal of trouble and expense was incurred in the replacing of range water-backs, and the amount of soap used in the laundry and lavatories was excessive. The presence of considerable iron in the water discolored materials washed in it, gave an unpleasant taste and affected the quality of ice made at the refrigeration plant. It



AERATOR BUILT ON TOP OF OLD SAND CATCHER

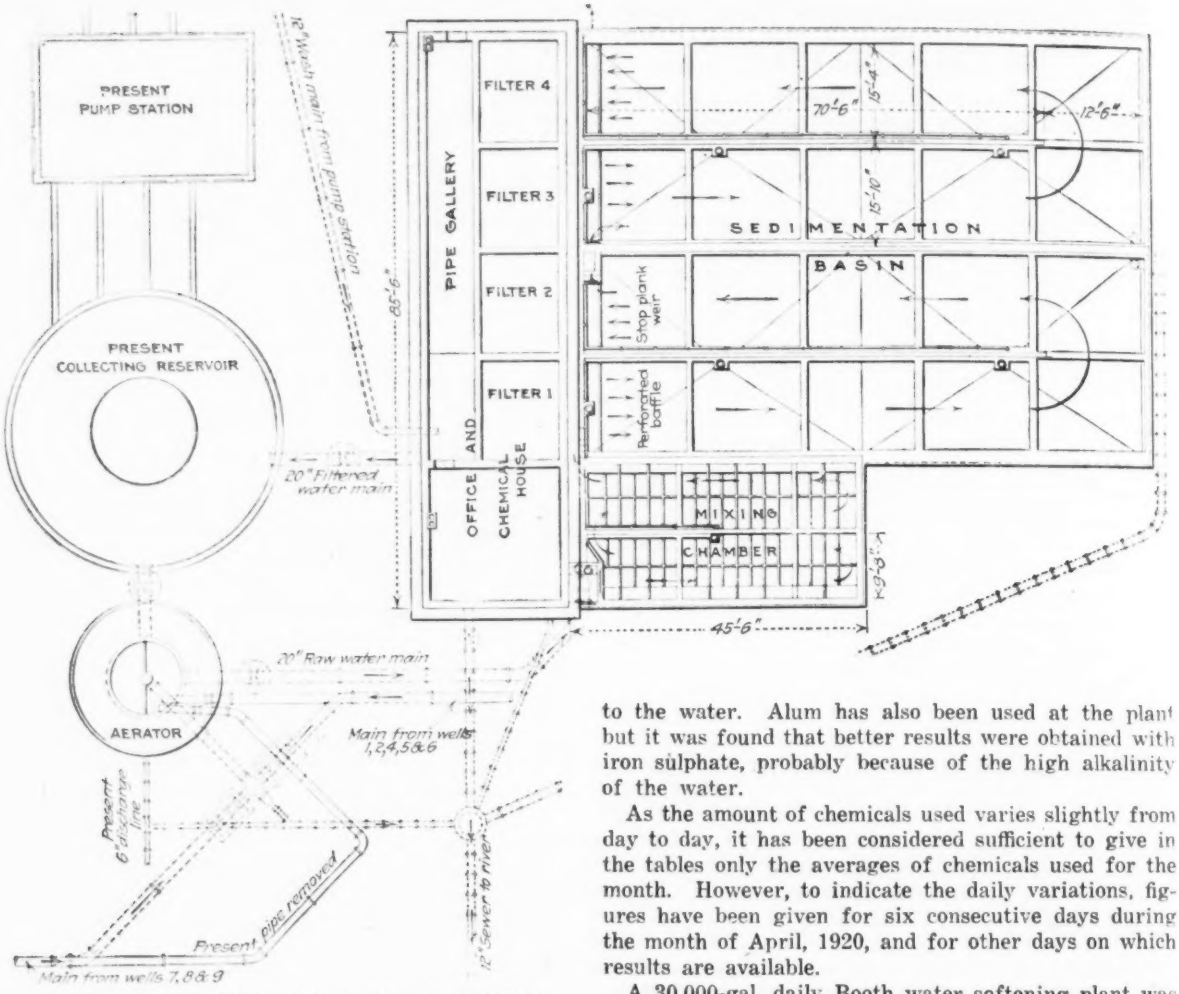
was discovered that growths of the iron fungus Crenothrix occurred in the mains of the distributing system. Some broken pipe revealed the fact that there was gradually accumulating a slime on the interior of the pipes of the districution system which was of cast-iron construction throughout. For these reasons an appropriation of $60,000 was obtained more cheaply for the deferrization and softening of the water. As an added precaution the water, after being filtered, has been treated with liquid chlorine.

Inasmuch as it was realized that Camp Funston would undoubtedly remain a permanent training camp, the plant is of permanent construction throughout, being of reinforced concrete and brick. It was realized that it might become necessary at some future time to obtain a permanent supply from the Kansas River and the plant was designed with the idea in view that it might be used to treat river water.

Convert Sand Catcher Into Aerator—A small amount

RECORDS OF OPERATION, FILTRATION, WATER SOFTENING AND DEFERRIZATION PLANT AT CAMP FUNSTON, KAN.

	Date 1919	Filter Hours	Length of Run Hours Max.	Min.	Ave.	Rate Mil. Gal. per Acre per Day	Units Washed	Per Cent. Wash Water	Grains per Gal. Alum	Lime	Soda Ash	Parts per Mil. Iron	Liq. Cl.	Alkalinity Raw	Fil.	Incrustants Raw	Fil.	Total Iron Raw	Fil.	Free CO_2 Raw	Fil.	Bacteria per C.c. Agar at 37° C. Raw	Fil.	Tap
	Sept. 2	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	..	....	....	10	150	...
	Sept. 8	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	..	....	....	50	16	8
	Sept. 17	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	..	....	....	2	5	3
	Sept. 25	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	..	....	....	1	15	3
	Sept. 30	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	..	....	....	14	17	3
Ave.	Sept.	25.9	12.9	11.6	12.6	115.0	0.75	1.10	....	5.77	0.37	....	.....	290	207	34.2	34.2	3.8	0	19.8	0.31	...	...	...
	Nov. 4	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	..	....	....	26	2	3
	Nov. 10	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	.....	..	....	....	57	...	39
	Nov. 20	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	..	....	....	147	88	128
	Nov. 24	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	..	....	....	125	70	100
	Nov. 30	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	...	....	....	..	....	....	200	65	90
Ave.	Nov.	20.2	13.2	6.15	9.7	136.2	0.5	0.89	0.97	5.44	1.31	0.37	.....	290	178	33.3	6.0	4.5	0	20.7	0	...	...	...
	Dec. 4	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	..	....	....	200	65	90
	Dec. 23	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	..	....	....	18	22	12
Ave.	Dec.	21.9	13.4	6.9	10.2	132.9	0.5	1.02	0.93	3.63	1.60	....	0.294	287	175	43.0	14.2	3.2	0	17.3	0	...	...	...
	1920																							
Ave.	Jan.	22.0	14.1	6.5	10.1	133.8	0.38	0.73	....	7.65	2.09	0.70	.....	295	159	49.8	22.8	3.6	0	17.1	0.13	...	...	...
Ave.	Feb.	29.2	15.5	8.5	11.0	121.4	0.4	0.80	....	8.46	2.10	0.69	.....	297	140	46.8	30.9	2.6	0	18.0	0	...	...	...
	Mar. 15	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	..	....	....	3	2	1
	Mar. 27	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	..	....	....	5	6	4
Ave.	Mar.	24.4	15.5	8.19	11.8	113.9	0.54	1.1	....	8.66	2.08	0.69	.....	296	143	39.6	20.9	3.2	0	17.1	0	...	...	...
	April 1	24.0	16.0	8.0	12.0	124.8	0	0	....	8.66	2.07	0.68	.....	300	150	40.0	20.0	4.0	0	17.6	0	...	...	...
	April 2	27.0	16.0	11.0	13.5	79.4	0	0	....	8.46	2.10	0.70	.....	290	144	41.0	19.0	0.4	0	18.0	0	...	...	...
	April 3	18.0	12.0	6.0	9.0	100.6	0	0	....	9.45	2.10	0.84	.....	298	144	40.0	19.4	2.4	0	18.0	0	...	...	...
	April 4	26.0	14.0	12.0	13.0	130.6	0	0	....	8.40	1.98	0.70	.....	300	144	42.0	21.0	4.4	0	17.6	0	...	...	...
	April 5	34.0	22.0	12.0	17.0	95.8	0	0	....	8.68	2.15	0.70	.....	300	150	44.0	22.0	5.4	0	19.0	0	...	...	...
	April 6	31.0	16.5	14.5	15.5	104.5	2.0	4.6	....	8.68	2.10	0.68	.....	296	150	40.0	20.0	4.8	0	17.0	0	12	8	10
	April 12	30.0	18.0	12.0	15.0	103.6	0	0	....	8.23	2.08	0.70	.....	290	140	40.0	20.0	0.4	0	17.6	0	14	10	7
	April 19	24.0	13.0	11.0	12.0	132.8	2.0	3.7	....	8.47	1.97	0.69	.....	290	140	43.0	21.0	4.2	0	19.0	0	9	8	5
	April 26	39.0	24.0	15.0	19.5	92.9	2.0	3.0	....	8.73	2.16	0.69	.....	300	150	40.0	20.0	4.4	0	20.0	0	12	8	9
Ave.	April	28.3	16.8	11.5	14.4	113.1	0.53	0.91	....	8.42	2.04	0.68	.....	298.6	147.2	41.5	20.1	4.0	0	18.0	0	...	...	...



WATER PURIFICATION PLANT AT CAMP FUNSTON

of fine silt is drawn into the wells during periods of pumping, so a sand catcher had been constructed to allow this material to settle out of the water before entering the collecting reservoir. In order to use as many of the original structures as possible, it was decided to convert the sand catcher into an aerator by rebuilding and widening it at the top and to allow the water to overflow from a vertical pipe down a series of baffle ways or cascades. Thus the water is spread out in a series of thin sheets or films and the resulting oxidization precipitate the iron in the water. It was felt that practically as good results could be obtained by allowing the water to mix with the air in thin films rather than in the finely divided state that might have been obtained by using sprays. The use of sprays would undoubtedly have resulted in an over-oxidization which would have been difficult to eliminate later in the process of treatment.

The main plant, consisting of a reinforced-concrete mixing chamber, settling basins, four 750,000-gal. daily rapid sand filters, pipe gallery and clear well under the filter plant, together with the brick filter house, was located directly east of the aerator, as shown on the drawing. From the aerator the water flows by gravity to the dosing chamber, where, under winter conditions, lime, soda ash and iron sulphate are added to the water. Alum has also been used at the plant but it was found that better results were obtained with iron sulphate, probably because of the high alkalinity of the water.

As the amount of chemicals used varies slightly from day to day, it has been considered sufficient to give in the tables only the averages of chemicals used for the month. However, to indicate the daily variations, figures have been given for six consecutive days during the month of April, 1920, and for other days on which results are available.

A 30,000-gal. daily Booth water softening plant was built for the treatment of the water for the laundry. In consequence, during the summer months it is not so important to obtain a considerable reduction in hardness at the main filtration plant because the heating plants are not operated at full capacity and the laundry water can be softened at the laundry. The September figures are characteristic of the summer operation and the other months are characteristic of the winter operation.

As the routine operation of the plant is done largely by inexperienced soldier labor, it has not been found practicable to obtain an accurate adjustment of the rate

SAND CATCHER CONVERTED INTO THIN FILM AERATOR

of application of the chemicals to the water in accordance with the hardness of the water to be removed, and average rates based upon the volume of water treated have been adopted. The water from the several wells varies somewhat in character and, if it were possible, it would be more satisfactory to vary the rate of application of the chemicals according to the well or wells used. The variation in character of the water from two of the wells is shown by the following analysis:

	Well 7 P.p.m.	Well 8 P.p.m.
Iron	7	0 3
Incrustants	67	20 0
Alkalinity	350	296 0
Carbon Dioxide	18	14 0

The following table shows the periods of detention of the water in the mixing chamber and sedimentation basins based on the average and maximum consumption for which the plant was designed:

Volume of Flow, G.P.D.	Hours in Mixing Chamber	Velocity Through Mixing Chamber, Ft. per Min.	Hours in Sedimentation Basin 1 Basin	2 Basins	Velocity Through Sedimentation Basin Ft. per Min.
2,000,000	0 61	3	2 7	5 4	1 0
3,000,000	0 4	5	1 9	3 7	1 5

The velocity of flow through the mixing chamber is about 5 ft. per minute when the plant is working under maximum conditions, but at the present time, because of the decreased population, the velocity is much less, and some slight deposits occur which must be removed at intervals. The sedimentation basins are arranged either for selective or multiple operation. At the present time the detention period in the settling basins has been increased to 12 hr. when one basin is in use and to 24 hr. when both are in operation. Satisfactory sedimentation of the flow has been obtained in these basins. The deposits are allowed to accumulate to a maximum depth of 3 ft. in the basin, giving an average depth of 18 in. over the whole bottom before the basins are cleaned. As the basins are not covered, algae growths, especially with the present low flow, have occurred in the basins. A luxurious growth of Spirogyra appeared when alum was being used as a coagulant.

It has been found necessary to clean each filter at intervals of about 2½ days when a loss of head of 8½ to 9 ft. has been reached. As water under 70 lb. pressure is available for washing, it has been found unnecessary to use air. The percentage of wash water given in the table is occasionally somewhat high for filters treating water without turbidity, thus showing that there is probably more water used than is necessary. The water is treated with liquid chlorine in the suction main of the pumps at a rate of 0.3 parts per million.

Results of Treatment—During the summer, little reduction of permanent hardness is effected, but the iron and free carbon dioxide are materially reduced. During the winter months, the alkalinity and permanent hardness are reduced slightly more than one-half, which would be considered satisfactory from a practical and economical standpoint, but it is possible that at certain times more chemicals are used to produce the results than are necessary. The analyses show no iron in the treated water, but this is probably due to the fact that the methods of analysis used are not sufficiently sensitive to indicate small amounts of residual iron.

The results of bacterial analyses show that the number of bacteria in the raw water is small and that a slight increase sometimes occurs in the plant. Occasionally, a high count for a well water is obtained, especially when it is considered that the counts are made on agar. Intestinal bacteria are almost uniformly absent from 0.1, 1 and 10 cc. samples.

In general, a satisfactory iron removal and softening is accomplished, and a water of safe, sanitary quality is being obtained. A considerable saving in the amount of soap has been effected, the amount of coal used at the central heating plants has been decreased and the disagreeable taste and odor due to iron in the water have been eliminated. The previous trouble experienced by the discoloration of laundered goods and shrinkage of woolens has almost entirely disappeared.

Mississippi River Floods of 1920

By Alfred J. Henry
Of the U. S. Weather Bureau.

THE spring flood in the Mississippi above St. Louis was the most severe at Dubuque, Ia., since 1888 and at Davenport since 1892. This flood had its origin in the melting of the snow cover in Minnesota and Wisconsin during the last half of March. The snow-water flood had not passed below La Crosse, Wis., when a rainstorm passed over the watershed augmenting the flood flow very materially. The flood was most severe in the stretch of the river forming the border between Illinois and Iowa. Levees on both sides of the river near Muscatine, Ia., gave way and about 85,000 acres of rich agricultural lands were overflowed. The probable loss in prospective crops is placed at $3,500,000. Fortunately no lives were lost.

Lower Mississippi: The spring flood of 1920 in the lower Mississippi was the second great flood in recent years that was confined between the levees. (A small break occurred on April 17 about 75 miles below New Orleans, but it was soon repaired.) The crest stages in this flood fell about 2 ft. short of the 1916 flood but the duration of the high water was considerably longer. In this respect the 1920 flood set a new record for that stretch of the river between Greenville, Miss., and the Passes.

The 1920 flood, both as to magnitude and duration, was in some measure due to the weather conditions six months earlier. The heavy rains in October and November, 1919, caused a rapid rise in the streams of the lower Mississippi drainage and this rise was further augmented by the rains of December of that year. As a result the mean stage of the Mississippi at Memphis for December, 1919, exceeded the previous mean high water record by 8.1 ft.; at Vicksburg the river on Dec. 31, 1919, stood within 2 ft. of the flood stage, and although it fell after that date the fall was arrested before a stage of 25 ft. was reached.

Beginning on Jan. 13, 1920 a series of three separate flood flows mainly from the Ohio passed down the river the second of which crested at Vicksburg on April 20 at a stage of 50.8 ft., 3.1 ft. short of the highest stage of record. The river was continuously above flood stage at Vicksburg from April 4 to June 13, or 71 days. At New Orleans the river was continuously above flood stage from April 15 to June 22, or 69 days, and the crest stage fell short of the previous high water by only 1.6 ft.

Some Observations on Man-Power Engineering

Mental Attitude of Worker Must Be Known—Every Laborer Wants (1) A Job That Pays a Living Wage; (2) A Home; (3) Leisure; (4) Freedom in Using His Leisure—Must Arouse Interest in Work and Avoid Paternalism

By Charles F. Dingman
Engineer, Flynt Building & Construction Co., Palmer, Mass.

MAN-POWER ENGINEERING is a term suggested in a most excellent article by Frances A. Kellor, Associate Managing Director of the Inter-Racial Council, in *Engineering News-Record*, March 11, 1920, p. 517. Miss Kellor points out that, as the greatest returns from the use of any other power are obtained by the application of engineering principles, the greatest returns from human labor will be obtained by approaching its use as an engineering problem.

Man-power cannot be separated from the man, so the problem of its most effective use is rendered vastly more complex than any other power engineering problem and presents phases which seem to baffle all possibility of solution in the light of present knowledge. Yet the crying need of the entire world for greater production of necessary commodities demands that man-power, as well as all other available forms of natural energy, shall be most efficiently and effectively used.

For years we have been reading of the wonderful results achieved through efficiency work and scientific management, yet we are told that in many lines of industry the actual unit production per man-hour is considerably less than it was before the war. Can it be true that all the studies—psychological, physiological, and otherwise—that have been made have failed to find the means of inducing the laborer to yield up his full productive power?

Must Know Worker's Mental Attitude

Before we can discover those engineering principles whose application will enable us to secure the greatest return per unit of energy expended, it is necessary for us to know something of the worker's attitude of mind toward his work and what will induce him to apply his labor-power most effectively. The one important fact that the average student of man-power engineering fails to grasp is that the worker, as does every other human being, considers it his most important function to live and to enjoy himself and that his work is only a means to that end. The sooner employers and others divest themselves of the idea that a worker's sole function is the production of commodities, the sooner will we have an end of the labor problem.

Parenthetically, it may be well to observe that, although it does not always occupy the center of the stage as at present, the labor problem is always with us. Most of the time, however, the problem belongs to the worker and is a problem of finding how to dispose of his labor power so as to procure a living for himself and family. At present, the labor problem seems to belong to the employer and consists in first obtaining and retaining a sufficient supply of the right kind of laborers and then in inducing those laborers to produce their full quota of product. The function of man-power engineering is primarily to solve the labor problem for the employer, though, as we shall see farther on, its correct solution will be equally as beneficial to the laborer as to the employer.

Before we can adopt the measures which will result in the greatest productivity from each laborer, we must find out what the worker expects to get when he sells his labor-power. In other words, why does the laborer work at all? Primarily, he works for food, clothing and shelter for himself and family, but unless actuated by a desire for something more than those rudimentary needs he seldom develops a capacity for any great productivity. It is the desire for something beyond, something that lifts him above a mere animal existence, that inspires the laborer to put forth the supreme effort. And it is because capitalists, managers, welfare workers and others have only vaguely sensed that idea in the past that we have such an acute production problem at present.

Four Things Every Laborer Wants

What every laborer wants, and this applies to all races and types, is: (1) A job that will return him a wage, properly adjusted to the cost of living. (2) A home. If he be married his ideas of a home will probably differ materially from those of a single man. (3) Leisure. (4) Freedom to use that leisure according to the dictates of his own individual temperament. These wants are basic, but every nationality has its own particular group of wants which were developed as a result of their "old country" environment and, in addition, every individual has peculiar wants of his own. It is only by learning what those wants are and how to utilize them that we can secure the maximum production from the laborer and I believe that we shall find that management has to date developed but a small fraction of the total productive power that the laborer will yield when he is approached in the proper manner.

The purpose of man-power engineering is to determine those conditions under which the laborer will sell and deliver the greatest amount of productive labor power for the given wage. Generally speaking, that set of conditions which permits the greatest play of individuality, arouses the greatest amount of interest in the work, best satisfies the actual human wants and yet avoids all paternalism, will also secure the greatest productivity.

We often hear the statement made that the reason for the existence of the present labor problem is that the employer, because of the great increase in the size of the industrial unit, no longer finds it possible to become intimately acquainted with all of his employees but is separated from them by the managerial organization. I do not believe this has any basis in fact. I have known strikes to occur in mills where the owner made it a part of his daily program to meet and talk with every worker in the plant. I have known employers who were always at loggerheads with almost every man in their employ. If the employer is a good leader of men he can inspire the laborers with a desire to increase their output and show them how to do it;

otherwise he might better stay in the office. The men are not half so keen about meeting the employer each day as they are to have the management recognize the fact that they are human beings and to see that they are treated accordingly.

The laborers want homes. Unless men can find suitable homes within reasonable distance from their work, their productive efficiency is bound to suffer. Different people and different nationalities have widely varying ideals as to how to furnish and how to keep a home, but it may be considered axiomatic that people who have a comparatively high standard of home life will possess corresponding standards of workmanship and productivity.

One of the most effective measures for insuring a well maintained rate of productivity is to make sure that there is always a sufficiency of the proper kinds of houses available in which the workers may make homes for themselves. There need be no taint of paternalism attached to an industrial housing program, even though it may not be possible to show a profit on the housing account or though it may be necessary to charge the loss on the housing account to production costs. The need of houses has become so great in many industrial communities that men have to travel long distances to their work and their productivity suffers accordingly. Beside this, the high rates of fare which they must pay in traveling back and forth make deep cuts into their wages and breed further dissatisfaction.

Leisure and Freedom to Use It

The workers want leisure. Physiologists and psychologists are all agreed that functions are performed with greater intensity and efficiency when periods of activity are alternated with proper periods of rest. This means that the working day must be long enough to secure the maximum results and yet not so long that the accumulating fatigue reduces the hourly rate of production until a long day's work produces less than a short day's work.

Stopping work at Saturday noon is becoming almost the universal practice in manufacturing establishments. This half holiday fills a need that no Sunday can fill because it gives the worker a chance to visit many places that would be closed on Sunday or to enjoy sports which might not be approved of on Sunday. Every reasonable opportunity which the worker has for forgetting his job helps increase the intensity with which he will attack it upon his return to work.

The workers want freedom to use their leisure as they see fit. It is true that great good may be accomplished by tactfully leading the laborer into making a better use of his leisure periods but when intrusive efforts are made to coerce him into liking the recreations someone else has picked out, he is very likely to assume an attitude of sullenness.

In this connection there is another factor to be considered. The provision of company club-rooms and other personally conducted recreations may be beneficial to an individual industry located in a small town by making the workers satisfied to stay in that place but, if that is all they accomplish, their effect upon industry in general may be decidedly negative since we are all agreed that the essential need at this time is not so much satisfaction as it is increased production. It is quite possible to carry this sort of welfare work to the point where the worker may become over-coddled, to his own personal injury, as well as to that of the industry.

Satisfied people, when the satisfaction comes as a result of things which are done for them rather than from things which they do for themselves, have a tendency to lose interest in putting forth any greater amount of effort than is absolutely necessary.

Interest in Work a Factor in Production

There is another factor—want does not seem to be the proper term for it—that governs the productivity of all men, but it does not ordinarily come into play in wage labor until the wants previously discussed have been fairly well satisfied. That factor is interest in the work.

It is easily demonstrable that, where an actively sustained interest in the work exists, a person can and will perform tasks that would ordinarily be impossible. Interest will ward off fatigue and quiet dissatisfaction, yet to arouse interest in some of the monotonous tasks which form important parts of modern industry seems well nigh impossible. It is here that the real problems of man-power engineering are to be found.

Interest in the work is inspired in as many different ways as there are different employers and employees. Here I believe is the explanation for the failure of many apparently scientific attempts to increase production. The persons making these attempts have properly evaluated all of the mechanical factors, yet because they considered the laborers merely as so many units forming a group, instead of a number of highly differentiated individuals, they failed to get that interest.

This is one of the reasons why comparatively high wages, bonuses, profit sharing, etc., do not always continue to produce big results, even though a sufficiently high wage to properly support life is necessary to maintain any interest at all. This is why the reputed labor policy of Lenine is bound to fail. It is said that he insists upon absolute submission to the director of the industry and absolute concentration upon the work during working hours. Because he is operating with men who have had to submerge their individualities for so long, men who believe they have cast off the yoke of the oppressor and are now working for an industrial commonwealth, which is themselves, he may succeed for a time; but sooner or later he will have to change his policy and learn how to maintain interest. Lenine may keep the workers from doing anything but work during working hours, but he cannot make them take an interest in their work by merely commanding it.

This matter of sustained interest requires a careful study of the individual personality of every laborer and every executive in the plant. There are certain types of executives whose attitude quickly destroys interest; among them are those who maintain an air of superiority when in company with the workers, those who feel that they must be spoken to in a certain particular manner, those who cannot exercise sufficient control over their emotions. There are other types who seem naturally to enthuse those who work with them. There are men for whom laborers will gladly leave other jobs and for whom they will work harder and for lower pay than they will elsewhere. These are the men who never forget that the laborers are just as human as they are themselves.

In studying how to arouse and sustain the interest of the laborer we must learn what his individual ambitions are and learn to tie the work which he is doing up to his ambitions. For instance, some men are interested in security in their old age. Old age pensions appeal to these men while they hold no interest at all to the strong individualist who is out to make a big success.

Bonus payments and profit sharing have their particular appeals to certain types of workers but tend to lose their effectiveness unless administered with the greatest fairness and unless means are used to show up the effect of the daily product upon the payment which results therefrom. The most recent studies of profit-sharing schemes seem to show that, while they may produce highly satisfactory results as regards the men occupying positions of at least some authority, they generally fail to arouse any deep or sustained interest in the rank and file of employees in any large industry. On the other hand, bonus payments based upon either individual or group production and figured over comparatively short periods of time, preferably every day, show the worker just how his effort is affecting his income. Remarkable results have been achieved by this method.

Workers as Partners in Industry

Perhaps the most enlightening information that has been published on this important subject of enlisting the worker's interest is contained in a pamphlet entitled "Human Relations in Industry," by R. B. Wolf, published by the Associated Industries of Massachusetts. Mr. Wolf tells us of the remarkable change which was wrought in a pulp mill when the management took the workers into their confidence and showed each man just how his work affected the work of every other man in the plant and how it affected the total output of the plant. The next step was to arouse a friendly competition among the men; not to see who could produce the greatest quantity, but to see who could produce the best quality of goods. As a result of these measures he found the workmen taking the keenest sort of interest in their product and suggesting changes in plant and in methods that would enable them continually to improve their product and increase their output. He tells us that they increased the yield of pulp from the wood by 17 per cent, a highly commendable performance from a conservation standpoint, and saved, in one year, $340,000 in raw materials.

What Mr. Wolf accomplished was to put the workers in the position of associates with the management. He says nothing in his pamphlet about "shop councils" or other species of formal shop democracy, but each workman was given a chance to exercise that creative ability which is one of the traits distinguishing men from animals.

Here, then, seems to be the answer to the country's greatest problem. The worker who sells his labor power must be given an opportunity to deliver it in the most effective manner and this can only be accomplished by providing him a means of self-expression in every task. This instinct for self-expression is possessed in a greater or less measure by every human being and to it the race owes practically all of its development. Yet so little has its importance been appreciated that the great aim in organizing modern industry seems to have been to arrange matters so that only a chosen few should find opportunity for self-expression. Those who have failed to find that opportunity we have been pleased to consider as lazy, shiftless or lacking in ambition. Yet, who is there who cannot think of at least one instance of a man, who was building himself a reputation for worthlessness, suddenly being thrust into a position which called forth his powers and made a man of him?

It is the man who can get away from the idea of forcing the worker into doing things his own way, the man who can lead the worker with the idea of "let us do this," who can induce the worker to put his own self into the work, and can show him how the materialization of his ideals and the achievement of his ambitious will follow from it, that is the true man-power engineer.

Turbine Case Blowout Repeated at Wachusett Power House

Accident of 1919 Duplicated on Similar Water Wheel—Failure of Case Due to Water Ram from Shift in Governor Control

ON FEB. 17, 1919, the upper section of the cast-iron scroll case of turbine No. 2, one of four similar wheels in the hydro-electric power station of the Wachusett dam of the Metropolitan Water-Works of Boston, Mass., blew out, following the changing of the governor from automatic to hand control. Repairs were made and order placed for revision of the governor system of all the units, but before the latter could be accomplished a precisely similar accident occurred to turbine No. 4 on May 3, 1920. Some studies are still under way following the latter accident, but sufficient data have been made available by William E. Foss, director and chief engineer of the Water Division of the Metropolitan District Commission, to warrant a description of the two failures.

The working floor of the Wachusett power house, just behind the Wachusett dam, is about 92 ft. below high water in the reservoir. The plant includes four 1,000-kw., 13,800-volt, alternating-current generators directly connected with horizontal-shaft hydraulic turbines which operate at a speed of 400 r.p.m., and two 60-kw., 125-volt, direct-current exciter generators also operated by turbines. Each of the main turbines is provided with a type Q Lombard governor arranged for automatic or hand operation as desired. The water-supply for each unit enters the gate chamber through ports in the upstream face of the dam and after passing the screen enters a vertical circular wall 7 ft. in diameter through two openings, each 6 ft. high and 2½ ft. wide. From the bottom of the circular well the water flows through a horizontal cast-iron pipe 4 ft. in diameter for a distance of 115 ft. to a point under the turbine and rises vertically 15 ft. to the base of the scroll case. Vales and gates are provided at the dam and at the base of the riser pipe.

On Feb. 17, 1919, the machinery at the power station was started about 6:30 a.m. and had been running smoothly with exciter No. 2 and units Nos. 1, 2, and 4 in operation for nearly an hour when the operator noticed that the oil feed pump of turbine No. 2 was not working properly, and with the helper proceeded to

prime the pump with the turbine running. Upon throwing off the pump belt, however, some trouble developed and the operator went to the switchboard and threw the load off the No. 2 unit. As he was returning the helper pulled out the governor clutch to change from automatic to hand control and immediately a section of the upper part of the scroll case, having an area of about 17½ sq.-ft., blew out as shown in the left hand of the accompanying two views.

The water flowed out of the opening in the scroll case under a head of 70 ft. and caused considerable damage in the powerhouse and in the superintendent's office, which was on a mezzanine floor off of the power room. The operators managed to get to the top of the dam and to shut off the flow by the main sluice gate within a half hour.

The details of drying out the electrical apparatus which had been flooded were somewhat involved, but the satisfactory performance of the machinery was achieved soon after the accident.

In the opinion of the engineers of the plant the break was caused by the sudden closing of the wicket gates at the turbine, which occurred while changing from governor to hand control. Experiments made on one of the other turbines following the accident showed that the governor could be cut out without any tendency for the wicket gates to close for varying gate openings up to five-eights of the full opening. At this point, however, the gates closed suddenly, with a resulting water ram. In one of the turbines, for instance, a water ram is shown of 5 to 10 lb. in connection with operation under governor control and of 60 lb. when the clutch is pulled with a wicket-gate opening of 63 per cent.

Examination of the broken casting showed that it was slightly less than the designed thickness, which was about ⅝ in. at the center of the break. There were indications of internal strain of the casting at the hub or thick section formed by the guide vanes. A new casting was obtained for repairing turbine No. 2 with a thickness 20 per cent greater than that of the original design, and the guide vanes were cored to prevent internal strains in cooling. For future contingencies consideration was given to the installation of air chambers, of storage tanks, and of dash pots on the gate-closing mechanism, but for various reasons these were not adopted. However, the operators were instructed not to attempt to cut out the governors with the turbines in operation, and arrangements were made to change the hydraulic governors from the closed to the open system to insure greater reliability. In the closed system the oil used in operating the governor is entirely inclosed and gradually decomposes and breaks down, corroding the delicate parts of the mechanism and forming gritty precipitates which interfere with the satisfactory operation of the governor. In the open system the oil is pumped from and returned to an open sump tank provided with the necessary strainers. With this arrangement the oil remains in its original condition and the operation of the governor is thought to be more reliable, especially after a shutdown for repairs or for any other reason. The order for this revision has been placed, but the change had not been made prior to the second break which occurred on May 3 of this year in turbine No. 4.

At this time trouble developed with the governor when starting up in the morning and the assistant operator put the unit into service by hand control and blocked the gates. Later, when the head operator arrived, the governor was adjusted and preparations were made to shut down the unit and put it into service again under governor control. In connection with this manœuver, the head operator slipped and fell against the governor stand and the break followed. This break was in practically the same place on turbine No. 4 as the first break on turbine No. 2. The two views herewith show the similarity of the breaks. Neither of the operators remember just how it happened as both were knocked down by the escaping water and received injuries which required hospital treatment. There is every reason to conclude, however, that the operators lost control of the gates and allowed them to close suddenly, although there is no indication of water ram pressure on the recording pressure gage chart. The damage resulting from the second accident was of about the same nature and extent as from the first accident, which cost about $8,000, and the work of repairing is being conducted along similar lines.

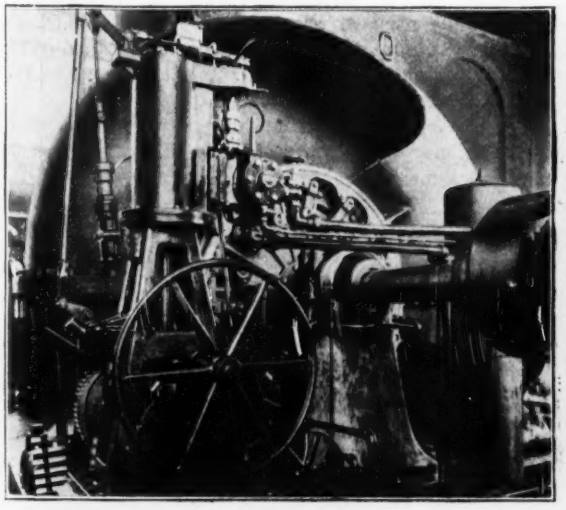


FIG. 1. BREAK IN TURBINE CASING NO. 2, FEB. 17, 1919

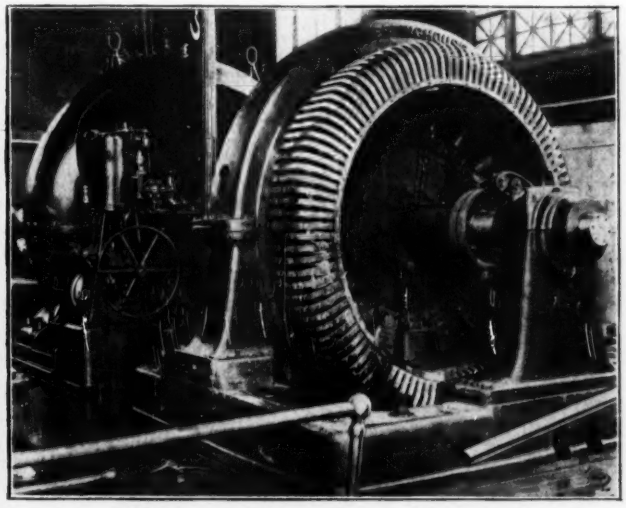


FIG. 2. BREAK IN TURBINE CASING NO. 4, MAY 3, 1920

A System of Filing Drawings

By NELSON HALL
Detroit, Mich.

IN every drafting room there is the problem of filing drawings so they can be readily found when wanted. Many systems have been devised all of which have more or less merit. Some are better suited to one drafting room than another. For a particular shop the following system was devised and will be described so that any one interested can make the equipment necessary.

Take two heavy paper clips *a* and *b* as shown in the sketch. The stiffer they are the better. Solder these to a rod *c-d* which is about ⅜ in. in diameter and about 15 in. long. At the middle of *c-d* solder hook *e* so the whole can be hung up conveniently.

A wire stretched across the room or a cabinet makes an excellent place to hang packs of drawings in the above clips as shown. But drawings hung in the open have

SCHEME FOR FILING BLUEPRINTS

a tendency to curl and to gather more or less dirt, so when this system is used permanently a cabinet should be made on the plan of a wardrobe trunk or a clothing store fixture for holding suits of clothes. *A* is a set of drawings held by hook *C* to slide on rod *D*. *D* is supported by roller *E* in front and rollers *G* and *H* at the back. These rollers run on rod *K* which in turn is supported by *L*. Rod *K* is the full depth of the cabinet. When a pack of drawings is to be selected the carrier *D* is drawn forward so the labels can be read. By keeping the drawings packed in a case they will stay straight and remain clean.

For the shop in mind the standard sheets were 18 x 24 in. Larger drawings were 36 x 36 in. and 36 x 48 in. These folded into 18 x 36 in. and 18 x 24 in., so all the clips were made for sheets 18 in. wide.

In developing an idea many drawings are made that are only good for reference, but they must be kept as they mark the progress and are often useful in establishing dates. It is convenient to have a clip for drawings as they become obsolete and another for the "live" or working drawings. In our practice of developing we often label our clips in this manner. Mach. No. 10, Obsolete; Mach. No. 10, Working; Mach. No. 10 Tools; Mach. No. 10 Patterns. These divisions meet our requirements very nicely.

If a machine shop foreman wants some information we take down clip labeled "Working" and we have all the drawings that pertain to the machine shop in book form so they can be leafed or scaled as shown in the drawing. Should a discussion arise in the pattern shop the draftsman takes clip labeled "Patterns" and goes to this pattern shop with all the information available to make his decision.

Each shop and the work under development determines how the classification of drawings should be carried out. Often machines are developed that have not enough drawings to fill one clip, while others have more tool drawings than can be held in one clip. The great advantage comes from having all the drawings together so they can be leaved, measured, taken out and replaced as often as needed with least possible trouble.

Paving Cost Comparisons

AN investigation by the Chicago Board of Local Improvements of paving costs in other cities indicates that Chicago in 1919 paid from 8.2 to 50.8 per cent less for its paving than eight other large cities. Officials of the Board and the city council and representatives from the county and city real estate boards and the Chicago Association of Commerce recently visited the cities in question to gain cost information which will be used in hearings before the Board, at which citizens may protest on paving programs. The prices for completed pavements found are given in the following table:

All of the cities above mentioned, with the exception of Chicago, pay contractors in cash. Chicago pays in special assessment vouchers which are subject to 5 per cent discount. This amounts to 21c. per square yard on asphalt, 27c. on brick, 33c. on creosoted wood block and 31c. on granite.

City	Asphalt		Brick		Granite		Creosoted Wood Block	
	Cost per Sq. Yd.	Per cent Inc. over Chicago	Cost per Sq. Yd.	Per cent Inc. over Chicago	Cost per Sq. Yd.	Per cent Inc. over Chicago	Cost per Sq. Yd.	Per cent Inc. over Chicago
Chicago	$4.15		$5.24		$5.98		$6.24	
Detroit	5.10	22.9	6.85	30.7	7.00	17.5	*	
Buffalo	5.14	23.8	5.41	3.1	*		*	
Boston	4.52	8.9	*				6.89	10.4
Borough of Manhattan, N. Y.	5.51	32.7			8.53	42.6	*	
Pittsburgh	4.85	16.8	5.20	0.8	6.35	6.1	*	
Philadelphia	4.14+	15.2+	*		7.29	21.9	7.04	12.8
Baltimore	4.49	8.2	*		*		*	
Washington	6.26	50.8	*		*		*	

+ This is compared with Chicago Type "B" pavement costing $3.59.
* None laid in 1919.

What Can a Community Afford To Rid Itself of Malaria?

Based on a Paper by L. M. Fisher, Associate Sanitary Engineer, U. S. Public Health Service, Columbia, S. C., in Public Health Reports, May 28, 1919.

THE amount that a community is justified in spending to prevent malaria, considered from an economic standpoint only, is determined by the returns obtainable for the community upon such expenditure. If all malaria losses are figured up for the year and capitalized, the result indicates an amount for which the community would be justified in bonding itself to effect permanent relief if a bond issue were necessary, or a cash expenditure if a bond issue would not have to be resorted to. From the result thus obtained a sum must be deducted the interest of which would pay for the maintenance charges on the permanent work.

Thus, if the malarial losses were say $8,000 a year for the community, then figuring interest and sinking fund charges at 8 per cent, the losses capitalized would amount to $100,000. If maintenance of ditches, etc., would cost $2,400 a year this sum capitalized at 6 per cent would amount to $40,000. The community would therefore be justified in bonding itself for $60,000 or in raising and spending $60,000 in cash. Whatever additional value the community would place upon the comforts of being free from mosquitos, enjoying a good reputation as a healthful, energetic, enterprising town can be added to the sum of $60,000 above referred to.

If the community had a population of 3,000 the per capita first cost would amount to $20, but if the result sought, namely, the elimination of malaria, were accomplished the expenditure would undoubtedly be justified, although the per capita cost is high compared with costs in some places.

Let us assume that:

1. B equals the population in the community and
2. C is the per capita first cost of malaria control work, then
3. PC is the total cost of the work. Now if,
4. I is the interest and sinking fund charges in per cent, then
5. PCI is the total annual interest and sinking fund charge in dollars. If
6. M is maintenance in per cent of first cost, then
7. PCM is total annual maintenance charge, and
8. $PCI + PCM =$ total annual cost, interest and maintenance. If
9. R is per cent of population infected, then
10. PR is the number of infected persons in the community. Now if
11. V is the annual loss in dollars per person infected, then
12. PRV is the total loss to the community before control, and equals the average annual gain after complete control, and
13. $PRV - (PCI + PCM)$ is the total saving for the community $= P\,[RV - C\,(I + M)]$ and
14. $[PRV - (PCI + PCM)] \div P$ is the net average annual gain per capita $= RV - C\,(I + M)$ and
15. $[PRV - (PCI + PCM)] \div PC =$ annual dividend to community on first cost $= RV \div C - (I + M)$. Now if only partial control is effected and we let
16. F represent the percentage of control as 65, 85, 90 per cent, etc., then (12) will become
17. $PRVF =$ average annual gain under partial control. This factor F will appear in each of the equations following (12) and equation (15) will take the form,
18. $(RVF \div C) - (I + M) =$ annual dividend to community on first cost.

From this equation it is evident that, the greater the infection the greater the dividend; the greater the annual loss per person infected the greater the dividend; the greater the percentage of control the greater the dividend; and the less the per capita first cost the greater the dividend. The per capita cost alone does not determine the wisdom of undertaking the work. It must be considered along with the other factors.

By making a malarial survey, preparing an estimate of first cost and maintenance cost, estimating annual losses and probable degree of control and substituting for the factors in equation 18 an approximation of the dividend resulting from the control work can be effected. As illustrating that the dividend may be greater even though the per capita first cost is greater the following table is submitted:

	Town A	Town B
Assume		
Population infected, per cent.....	10	85
Losses per person infected, dollars	5	5
Degree of control, per cent.....	100	100
Cost per capita, dollars.....	1.5	10.
Result		
Dividend in per cent, from formula 18	18	27.5

Illinois Asks Proof of Engineers' Ability

That greater weight should be given to the professional attainments of applicants for registration as structural engineers in Illinois is the opinion of the committee of examiners under the Illinois law. On this ground the committee has recommended to the Director of Registration that submission of evidence of qualifications should be required as part of the examination specified by law. This situation was stated by T. L. Condron, a member of the committee, in a paper on "State Registration of Engineers," read before the Western Society of Engineers.

The Illinois structural engineering act as revised in 1919, provides for the examination of all applicants except those licensed or registered in another state or country where the requirements are equal to those of the Illinois law. This act says little about the scope of the examination, but does provide that the State Department of Registration and Education may adopt rules and regulations relating to the enforcement of the law. The examining board holds that ability to pass an examination is not adequate proof of the fitness of applicants to receive certificates of registration. Its action in advocating evidence of work and experience is in line with the proposed uniform registration law recommended by the committee of the national Engineering Council.

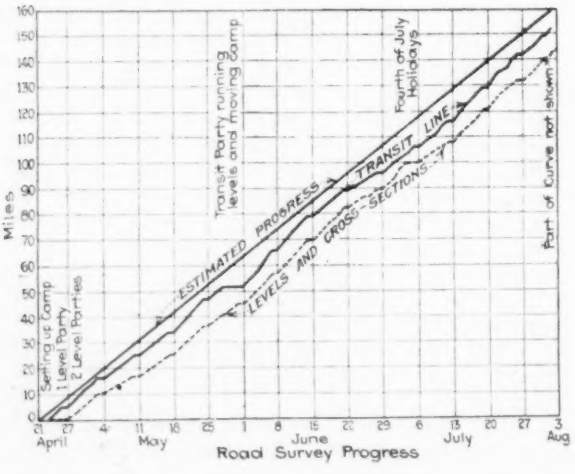
Illinois now has three registration laws, applying to structural engineers, architects and land surveyors. As the last applies only in Cook County, owing to population limitations, the State Department of Registration has declined to undertake its administration, and this has been assumed by the county authorities.

Graphical Records for Progress in Highway Surveys

By John E. Fontaine
Field Engineer, Morgan Engineering Co., Memphis, Tenn.

In *Engineering News-Record* of Feb. 12, under the heading "Graph Records Progress of Road Survey Parties," R. T. Brown describes an excellent system of progress reports. The writer has used graphical reports for a number of years but has found that the plan of platting the curves in the office as a record for the chief engineer does not fully realize the possibilities of the graph. The object of recording the progress of surveys is, of course, to enable the proper officials to keep in touch with the work of the field men and to remedy any failure on their part to maintain the standard rate . . for them. Some pre-determined rate of speed is necessary for any intelligent criticism of a progress curve, and this is made the basis of the scheme for a progress curve used on a recent road location survey in Arkansas.

The plan in brief is as follows: The field engineer is required to submit an estimate of the rate of progress to be attempted on the survey, and, if this meets with the approval of the chief engineer, it becomes the ideal rate of speed to be sought by the field parties. The field work then becomes a game in which all the field men have a part. Where two or more parties are engaged on the work competition may be stimulated by plotting separate curves for each party. The field engineer makes the game interesting by plotting the day's work after supper and posting all concerned as to their success or failure in keeping up to the standard.



The writer has found this plan highly successful in keeping his party "on its toes" and the result has been a good rate of progress under adverse conditions. The charted progress on the survey referred to is shown. One transit and two level parties were employed on the work. Transit line was run, staked, offset on section lines, and referenced, profile was taken, bench marks set and check levels run, and all the lines were cross-sectioned across a 100-ft. strip. About 30 per cent of the line was in woods and the remainder was over existing roads. Bad weather caused a loss of more than the 25 per cent allowance which was included in the estimate.

Cost-Plus Contracts for Water-Works Construction

By George W. Fuller
Consulting Engineer, New York

Extracts from paper read before American Water Works Association, Montreal, June, 1920

THE writer believes that water-works construction which reasonably can be deferred should not be contracted for at present. In the case of many water-works projects the existing works can with propriety be patched and overhauled in a manner similar to that adopted by the individual who under present stress makes use of old and patched clothes. But some water-works construction must go forward. Under these circumstances it is important to discuss briefly the cost-plus form of contract with a view to seeeing if the burden of uncertainty in some respects cannot be shifted from the contractor to the owner, to the advantage of all concerned. In fact, if construction work is to go forward there are some projects where such steps seem imperative.

Advantages Claimed for Cost-Plus Contracts.—1. The work may be started at any time and is not dependent on the prior completion of the plans.

2. The owner may radically increase or decrease the quantities during construction, with lump-sum fees subject to review.

3. The owner may change the kind of construction during the progress of the work.

4. The contractor will not try to skimp the job, as is often done after finding himself losing under lump-sum or unit-price contracts.

5. There is less need of having accurate preliminary estimates. In unit-price contracts the preliminary estimate is often so approximate as to cause the contractor to gamble on some of the items, with resulting disappointment to the owner in the ultimate cost of the work. Such procedures sometimes cause an unfair result either to owner or contractor or both.

6. Unit-price or lump-sum bids require a set of specification definitions which are not always clear and are sometimes deficient and sometimes overlapping. Such ambiguities may lead to arguments and variations in cost which result in claims and suits for extra work.

7. Cost-plus contracts may save the owner the money which the contractor usually adds to his lump-sum or unit-price bid to cover the complete but actually infrequent enforcement of material tests which cause him delay and expense, or necessitate the carrying of a large stock, entailing interest charges, storage space, rehandling, etc.

8. Cost-plus contracts do away with the substantial sums usualy added in lump-sum or unit-price contracts to cover the following uncertainties: (a) Weather. (b) Foundadations. (c) Changes and shortages in labor market. (d) Changes and shortages in material market. (e) Delayed deliveries of materials.

9. For cost-plus work it is the contract and not the specifications which is the crux of the matter from both the owner's and contractor's viewpoint. The writing of the contract is more simple than the writing of the specifications.

10. Cost-plus contracts tend to promote co-operation between the owner and the contractor.

Disadvantages Claimed for Cost-Plus Contracts.—1. There is no way of determining the approximate cost in advance and this upsets budgets where definite appropriations have been made or are required.

2. Competition, the key to efficiency, is killed.

3. Greater opportunity is offered for favoritism on the part of the owner's representative.

4. Where the same contractor has several jobs, the lump-sum and unit-price contracts will get the good workmen and the cost-plus contract will get the drones and misfits.

5. A large general contractor often takes a job on the cost-plus basis and sublets it to several smaller contractors on a lump-sum or unit-price basis. In making the sub-

contractors complete the work on the latter basis the general contractor often treats them unfairly while he himself may be receiving a substantial profit for doing little or nothing.

6. Should work be started before plans are completed, many errors mays have to be straightened out in cases where competent engineers would avoid them if given an opportunity to get out a complete sets of plans and accurate estimates of quantities.

7. Engineers are tempted to be less thorough in their work when they know that there will be no comeback at them on account of extras resulting from their failure to have plans and specifications complete when needed. With cost-plus contracts it may simply be a matter of correcting an error or supplying a deficiency when discovered, but the cost is there just the same, although it may not appear as an "extra."

8. Engineers or other representatives of the owner must do an immense amount of accounting and clerical work in checking payrolls, material bills, etc., and expend much time and energy in expediting the delivery of materials.

9. A premium may be put on extravagances and waste by giving unscrupulous contractors and engineers a chance to take advantage of the owner.

10. The contractor may procrastinate in securing if not refuse to secure adequate tools and equipment as to type and number.

11. A combination of the above disadvantages, although no one by itself may be sufficiently pronounced to permit the owner successfully to obtain relief, may cause grief for the owner, unless protected by a maximum fee to the contractor, and by the assured adequacy of the latter's organization and equipment.

Contract Adjusted to Varying Labor Prices.—Mr. Morris R. Sherrerd, chief engineer of the North Jersey District Water-Supply Commission, in a recent [proposed] contract for the construction of the Wanaque dam provided for an adjustment of certain labor costs after the year 1920, if such costs were 10 per cent above or below normal 1920 prices. This places the burden of changes in material costs on the contractor, but causes the owners to share with the contractor unusual changes in labor costs. The advantage of this type of contract as to labor over cost-plus agreements lies in the fact that the contractor is compelled to exercise the same careful supervision and that there is the same necessity for economical construction methods as is required on lump-sum and unit-price agreements, but he is not obliged to shoulder all responsibility for unexpected price changes.

In the Wanaque dam contract, labor is a controlling item, but on ordinary construction work, particularly on comparatively small jobs, and where the value of labor and material are more nearly equal, there would be less advantage in it. To be more generally applicable the adjustment in prices should, if possible, include material as well as labor, and furthermore the length of time between successive adjustments should also be made to conform to the size of the contract and to the probable duration of construction.

The adjustment of prices is more difficult in the case of materials than for labor, because of the greater number of materials and also because of the variety of materials which might satisfy any particular specification. On this account the furnishing of the principal materials to the general contractor through separate contracts made by the owner may be advantageous in that the risk would be more widely distributed and the adjustment of prices made somewhat more simple and definite.

At a time when transportation facilities are abnormally inadequate the assumption by the owner of the responsibility of furnishing materials cannot eliminate wholly the troubles arising from the enforced intermittent use of the contractor's laborers.

Summary and Conclusions. — Pre-war construction contracts were for the most part, and rightly so, agreements on a lump-sum or a unit-price basis. Cost-plus contracts were used only on certain large work done for private corporations or as a part of other types of agreements.

2. During the war the United States Government construction and much other work was done on a cost-plus basis. Where proposals on a lump-sum or unit-price basis were obtained, the prices were intended to be sufficiently high to insure against loss due to constantly changing prices and the scarcity of labor and material.

3. Since the war, the procedure has been somewhat unsettled, with an effort to do away with some of the disadvantages of cost-plus form and to combine so far as possible the good qualities of both types of contracts.

4. The unit-price contract, under normal stable market and transportation conditions, is the most satisfactory. The lump-sum contract is principally advantageous in that the final cost is definitely known at the outset.

5. Cost-plus contracts, with proper provision for accounting and supervision, may be satisfactory where conditions are not definitely known and in the case of private corporations where well qualified contractors may be selected to work under adequate supervision. Under war conditions cost-plus contracts were necessary and even now they have many advantages.

6. Construction work for private corporations may be successfully carried out with proper safeguards under any of the discussed forms of contract. For general construction work under municipal control the nearer a contract approaches the well-established lump-sum or unit-price contracts, if indeed any departure from such contracts is legal, the more satisfactory will be the results secured.

7. Until such time, however, as the material and labor markets are better established, contracts should in fairness place the burden of uncertainty on the owner and not on the contractor. This may be done as follows: (a) For much municipal work a form of contract may be adopted along the lines proposed by Mr. Sherrerd, and modified as suggested as to labor and material adjustments at proper intervals. (b) For municipal or other work contracts may provide for the furnishing by the contractor of such labor and materials as are reasonably stable, with adjustment for changes in the labor market, and with materials of unstable price furnished by the owner through separate contracts.

8. Construction work not absolutely necessary should be deferred, and materials and labor should be diverted so far as possible to work which is absolutely necessary.

9. So far as possible necessary improvements should be made repairing or enlarging present works, and new works should be confined for the present to immediate needs.

Government Standardization in the Building Field

If standard specifications could be prepared and agreed upon in a much larger number of cases than has yet been done, it would greatly facilitate the work of architects and builders. And if building methods and the requirements of city building codes could be thoroughly studied and revised this also would aid in reducing building costs. It seems probable that hundreds of millions of dollars could be saved within a few years if a comprehensive and intelligent study were made of all phases of building including fire prevention and the plumbing, heating, lighting, and hardware equipment of buildings. It would also reduce the cost of repairs and maintenance of these buildings; partly because deterioration would be slower and failures would be less frequent, and partly because repairs would be easier and cheaper to make. The government would do only a portion of this work of research and standardization, as many engineering societies, industrial organizations and manufacturers would co-operate. But the government should take the lead, and do an important part of the research work, and nothing which the government could do would be more useful and constructive or would be more appreciated by the building industries and the public.—From an address by E. B. Rosa, chief physicist, Bureau of Standards, on "The Economic Importance of the Scientific Work of the Government."

Mountain Lake Siphoned Down To Connect Tunnel Outlet

By F. T. Crowe
Manager Flathead Irrigation Project, St. Ignatius, Mont.

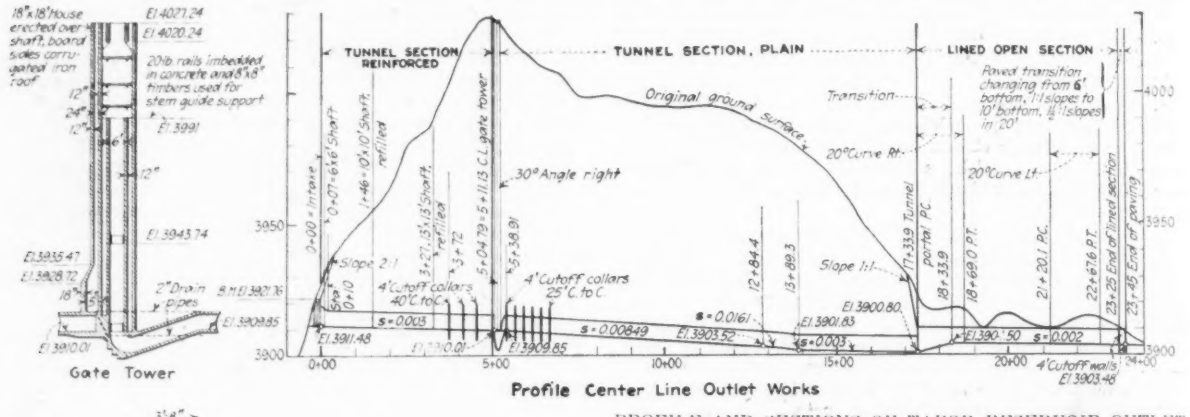
A SURVEY of storage possibilities on the Flathead Irrigation Projects, U. S. Reclamation Service, Montana, showed that the creek leading from St. Mary's Lake (renamed Tabor reservoir) was so located and had so rapid a fall that by driving a tunnel 1,750 ft. long with its outlet in the bed of the creek the lake could be tapped at a point 76 ft. below the normal water surface. By placing control gates in this tunnel a storage basin of 12,500 acre-ft. capacity could be secured—one of eight reservoirs on the project.

Two construction problems were apparent: (1) How to meet the danger of encountering such a flow of water in the heading of the tunnel as it approached the lake, with its water surface 76 ft. above the tunnel, that further tunneling would be impossible; and (2) what method of breaking the tunnel through into the lake should be used?

Test pits and borings indicated that the lake bed was covered with a coating of blue clay and that the tunneling, up to a point about 50 ft. from where it entered the lake, would be through a glacial moraine of sand, gravel and cobble rock. Stream gagings on the outlet creek indicated a flow of from 12 to 150 sec.-ft., the large flow occuring during May, June and July when the deep snow in the mountains was melting.

The construction plan decided upon was to start tunneling at the outlet portal and, if successful, to proceed to a point immediately below the shore of the lake at the high-water line, and to sink a shaft at this point to connect with the tunnel. The next step planned was to place two 24-in. riveted steel siphons, one leg extending out into the lake to a depth of 26 ft., and the other leg down the shaft to the tunnel, having valve control on the lower end. By the operation of these two siphons it was proposed to lower the lake approximately 26 ft. While this was being done the tunnel was to be carried forward until it reached a point immediately below the new shore line, 26 ft. below the normal water surface. Then another shaft was to be sunk at this point to connect with the tunnel. With this accomplished, and the siphons changed to the new shaft, the lake would be lowered an additional 26 ft. The tunnel would then be advanced and a third shaft sunk, the siphons reinstalled and the water lowered to a point about 8 ft. above the top of the tunnel. At this point a heavy shot would be placed in the heading, of sufficient strength to blow an opening to the lake bottom and permit the water of the lake to flow directly through the tunnel.

Tunneling was started in September, 1916, and progressed favorably until reaching a point approximately 500 ft. from the outlet portal, where a body of quicksand approximately 50 ft. through and discharging about 2 sec.-ft. of water was encountered. The heading was immediately breast-boarded and an attempt made to push ahead one board at a time. However, the pressure was so great and the sand so liquid that the later would squirt through any small hole in the heading so rapidly that it was found impossible to use any ordinary methods. Pipes were driven in in an effort to carry off the water and render the sand more stable. This was of no avail. The pipe clogged and became useless.



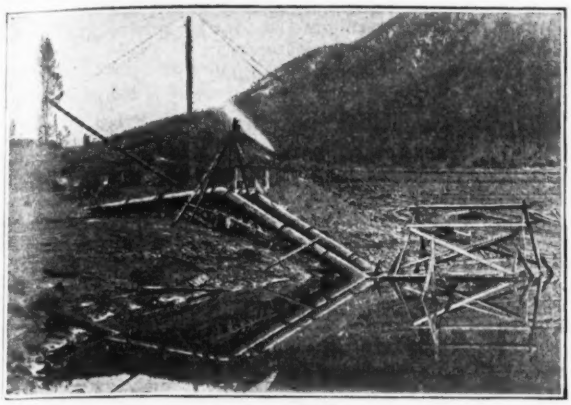
PROFILE AND SECTIONS OF TABOR RESERVOIR OUTLET TUNNEL, FLATHEAD PROJECT, MONT.

To connect the outlet tunnel with the inlet at the lake bottom so as draw this natural lake down 76 ft. the outlet tunnel was carried from its lower end to a point beneath the shore line, a shaft sunk, and the water siphoned off to depth 26 ft. This process was twice repeated; until the water was only 8 ft. above the top of the tunnel, when a hole was blown through from the tunnel heading to the lake bottom.

As a last resort, the heading was driven full of 4- to 6-in. jack-pine poles, about 14 ft. long. This permitted the water to run out between the poles but retarded the sand flow. By driving these ahead as the tunneling advanced and sheeting up absolutely tight and placing heavy timbers under the mud sills the tunnel was driven through the quicksand to the gravel formation which continued until the blue clay was reached under the lake.

Upon reaching the lake shore the tunnel was lined with concrete and siphons installed and placed in operation.

It was anticipated that perhaps some difficulty would



DOUBLE SIPHON LOWERING LAKE LEVEL

be encountered in priming the siphons when the lift was high but this was not the case. With a 2½-in. Pemberthy injector attached to a 20-h.p. boiler carrying 100 lb. steam pressure, it could be primed in seven minutes. The two siphons had a combined maximum flow of 125 sec.-ft.

The general construction scheme of unwatering the lake was followed as outlined with no serious difficulty, the lake being lowered in 150 days.

The high-pressure cylinder gates designed for this outlet by J. M. Gaylord and J. L. Savage, of the Denver office of the U. S. Reclamation Service, are tight and work with ease, having no serious vibration or rotating tendency, as is sometimes encountered with this type of gate.

The work was done under the supervision of the writer, assisted by F. F. Smith, resident engineer, and T. S. Martin, general foreman.

Economies in Car Repair Shop Design

POSSIBILITIES of great economy in the work of railway car repair shops by introducing mechanical handling equipment, in order to reduce manual labor, were suggested in a report and discussion on repair shop layouts at the annual meeting of the mechanical section of the American Railroad Association. The expensive results of a tendency to try and get along with present facilities were pointed out by C. E. Fuller, Union Pacific R.R., who said that economy lies in immediate action to secure adequate facilities for handling work and materials. In his opinion, the cost of work done by hand labor at present wages is not sufficiently realized.

Traveling cranes and gantry cranes will handle material and lift cars, thus reducing trucking and the slow and costly work of jacking cars by hand. With hand trucking, several men are likely to walk with the truck to help in unloading, although one or two men do the pulling. A tractor and truck service would effect a great saving in time and labor cost. Paving the standard gage material tracks, which alternate with the repair tracks in shops and yards, was recommended by the report in order to form roadways for tractor haulage.

The design of the repair shops will depend largely upon the crane equipment and the report recommends that the design should be handled jointly by the engineering and car departments. Whether car repair work should be done in shops or under sheds or in the open yard depends largely upon climatic conditions. It was pointed out by F. F. Gains (Railway Board of Adjustment) that even in the south the winter temperature is relatively low and men can work better in a closed shop properly heated. An indirect heating system can be utilized to supply cool air in summer. Men who have to work without shelter from snow, rain, wind and hot sun produce little effective work. Even a closed shop should be heated in winter so that the men can work in comfort. Plans for a plant with closed shops for turning out 100 cars daily were submitted, the plant to be built in units for 25 cars each. With 25 car spots or repair points, the output will be four and eight cars daily for heavy and medium repairs respectively; for light repairs, 50 spots can turn out 50 cars per 8-hour day.

More Tests on Concrete Elasticity

LAST YEAR at the American Society for Testing Materials meeting Stanton Walker presented a long paper on the modulus of elasticity of concrete as revealed in a great number of tests. Before the recent meeting a paper giving some further information on concrete elasticity was read by G. M. Williams of the United States Bureau of Standards, under the title of "Some Determinations of the Stress Deformation Relations for Concrete Under Repeated and Continuous Loading." Special attention in the tests was paid to the question of wetness or dryness in concrete. The conclusions are as follows:

1. The true stress deformation relations for concrete under loads even exceeding designing loads and loads applied in practice and up to 50 or 75 per cent of the ultimate strength may be represented by a straight line.

2. For a few specimens, composed of lean mix or very wet consistency concrete just removed from damp sand storage, it was found that the increment of deformation per increment of load for the first application of load only could be represented by an equation of the exponential type, but second and additional applications of loads resulted in a straight-line relation.

3. For ordinary working loads and up to 50 to 70 per cent of the ultimate strength of the concrete, 95 per cent of the value for modulus of elasticity obtained by dividing the unit stress by the unit deformation for that load will represent the true modulus with sufficient accuracy.

4. The modulus of elasticity for normal concretes is the same for any given material in either the wet or dry condition.

5. The modulus of elasticity is apparently increased slightly for repeated or long continued single applications of loads. The modulus of elasticity of concrete in a structure subjected to loads within design limits is probably slightly greater than the value found from tests of cylindrical specimens of the same concrete. The stress-deformation relation under such conditions can be represented by a straight line.

6. With any given cement and grading of aggregate of the same maximum size, and for any given proportion of cement to aggregate, the ratio of modulus of elasticity to compressive strength of concrete is fairly constant regardless of consistency or flowability.

Stanton Walker, of the Structural Materials Research Laboratory Chicago, disagreed with the conclusion that the stress-deformation curve of concrete is linear below the elastic limit and defended the curvilinear relation as observed in the tests reported in the paper noted above. He further observed that he could find nothing in the tests to justify conclusion No. 3 noted above.

Surface Area Measured by Maximum Bulking of Sand

Tests Establish Value of Readily Obtained Factor for Use in Proportioning Concrete Mixtures

IN ONE of the several recent theories of rational concrete proportioning use is made of the surface area of the aggregate as a basis of cement measurement. Hitherto this area has been determined by a combination of mechanical analysis with a rather laborious grain counting. In a long series of tests in the laboratory of the Hydro-Electric Power Commission of Ontario it has been found that this area appears to be a function of the volume bulking of the sand under water additions, and this bulking is suggested as a ready measure of the surface areas of aggregates for use in proportioning concrete. The subject is discussed by Roderick B. Young and W. D. Walcott of the Hydro-Electric Power Commission in a paper before the recent meeting of the American Society for Testing Materials. An abstract of the paper follows:

When a sand increases in volume because of an increase in its moisture content, it may be said to "bulk." Bulking is expressed quantitatively as a percentage or ratio. "Sand" is used in its commonly accepted sense: namely, a fine aggregate derived from a natural source all of which will pass, when dry, a screen having circular openings ¼ in. in diameter. "Silt" as here used means that very fine material in a sand which will pass a No. 150 sieve. Mechanical analyses were made of each sand from carefully prepared samples taken by the method of quartering. The sieves used were a perforated plate having ¼-in.- diameter openings and Tyler's Nos. 6, 10, 20, 35, 65, and 150. Grain counts were carried out on each size of separation for a representative sand from each locality and from these counts and the specific gravity, the surface area was obtained using the formula

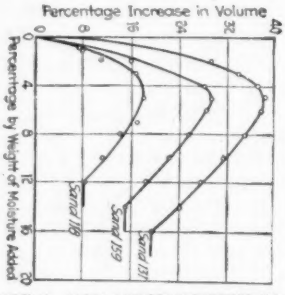


FIG. 1. RELATION BETWEEN MOISTURE CONTENT AND BULKING IN SAND

$$A = 236.1\sqrt[n]{\frac{n}{S^3}} \qquad (1)$$

where A = surface area in square feet per 100 lb., S = specific gravity of the sand, and n = number of grains per gram in any size of separation.

The increase in volume resulting from additions of moisture was obtained indirectly by determining the weight per cubic foot of the material first dry and then moist. Both ½ and ¼-cu.-ft.-capacity cubical measures were used at different times. The measure was filled by means of a cylindrical shell, open at both ends. This was placed in the measure, filled with the sand under test and slowly withdrawn. The capacity of the cylinder being slightly greater than that of the measure, an excess of material remained in the latter when the cylinder was removed. This excess was struck off with a straight edge. Several determinations were made on each sand and the results averaged. It was found that the method gave concordant results.

To obtain sands of different degrees of moisture a predetermined amount of water was added to the dry sand and thoroughly worked into it by kneading.

Knowing the weight per cubic foot of the sand both dry and moist, the percentage increase in volume due to the added moisture was calculated from:

$$P = \frac{W_1(1 + r) - W_2}{W_2} \times 100 \qquad (2)$$

where P = per cent increase in volume, r = ratio of water added to weight of dry material, W_1 = weight per cubic foot of dry material, and W_2 = weight per cubic foot of moist material.

Fig. 1 shows the percentage increase in volume obtained in this manner for three sands: a fine, a medium and a coarse. The mechanical analyses of the same sands are shown in Fig. 2. These curves are representative.

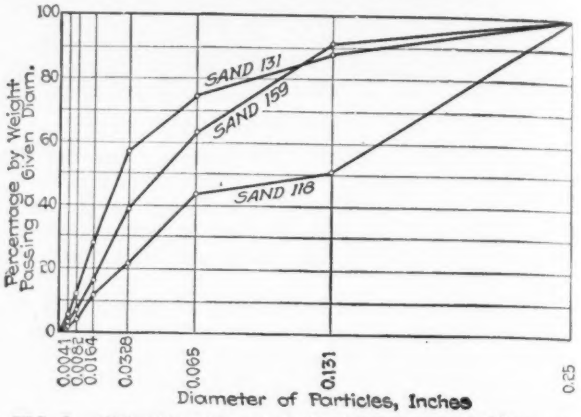


FIG. 2. MECHANICAL ANALYSES SHOWING RANGE OF SAND USED IN INVESTIGATION

A study of these tests revealed the interesting fact that the maximum percentage increase in volume, or bulking, is related to surface area. When plotted against surface area the points fall approximately on a straight line (Fig. 3). The equation of this straight line is

$$A = 40.6\,x + 180 \qquad (3)$$

in which A = surface area in square feet per 100 lb. and x = maximum increase in volume in per cent.

It may seem odd that the relation between bulking and surface area is independent of the percentage of water used to cause it. This would not be so were it not for the varying silt contents of the sands. Fig. 4 shows a relation between bulking and surface area for one, two and three per cent additions of water. However, to show this relationship it was necessary to plot only results from sands having approximately equal silt content. Other sands of different silt content would not conform to these curves.

Any silt contained in a sand will commence to absorb moisture as soon as water is added. This absorbed water takes little or no part in the bulking phenomenon. It is the moisture in excess of that absorbed by the silt that causes changes in volume. Sands of equal surface area but containing different percentages of silt will bulk differently for the same percentage of additions of water up to nearly the point of maximum bulking. At that point the variable effect of different silt contents is compensated for.

Experiments were also carried out upon sands having particles of uniform size. These sands were all prepared from one material by sieving it into its different sizes. Volume-moisture studies were then made

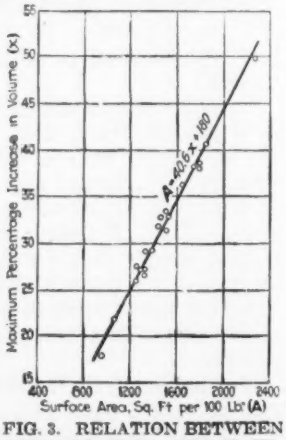


FIG. 3. RELATION BETWEEN SURFACE AREA AND MAXIMUM BULKING FOR GRADED SANDS

on each size. These experiments also showed maximum bulking to be related to surface area. But it was found that this relation did not follow the same law as with graded aggregates. It was found that sands coarser than that passing the No. 6 sieve did not increase in volume with additions of moisture. It is thought that the reason for this is that the weight of the particles of these large sizes is sufficient to overcome the separating effect of the film of water surrounding the moistened particle. This explanation has not as yet been tested out experimentally. A few experiments were made with mixtures of sand and gravel. Only one sand and one gravel were used but these were mixed in different proportions. Here also a relation between bulking and surface area was found. Successive additions of gravel decreased the percentage of maximum bulking in the same ratio as it decreased the surface area. Fig. 5 illustrates the results of these few tests. It is at once apparent that if the laws here indicated are general, the maximum bulking of sand or of a sand-gravel mixture could be determined if its surface area was known; conversely its surface area could be determined if its percentage of maximum bulking was known. It is evident, however, by the behavior of "one-size" materials that these relationships are not perfectly general since the large-size particles take no part in the bulking phenomenon.

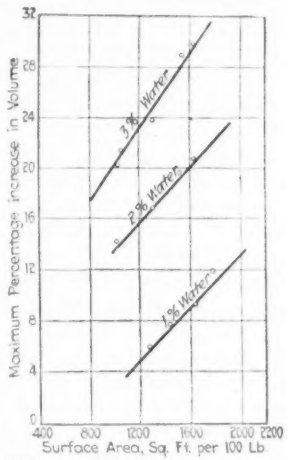


FIG. 4. RELATION BETWEEN SURFACE AREA AND BULKING FOR DIFFERENT MOISTURE CONTENT

An experimental study of the limitations within which the conclusions hold have shown that the following is approximately true:

1. Extremely coarse sands, sands in which over 60 per cent by weight will not pass the No. 10 sieve, give results higher than those obtained by mechanical analysis. Sands of these characteristics usually have surface areas less than 1,000 sq.ft. per 100 lb. They will usually be detected immediately by an experienced observer.

2. Extremely fine sands, sands in which 50 per cent passes the No. 65 sieve, give results lower than those obtained by mechanical analysis. The sands are really "one-size" materials and usually contain a high percentage of silt. They have surface areas in excess of 2,000 sq.ft. per 100 lb. As in the case of the coarse sands they can usually be detected by examination

Silt, when present in excess of seven or eight per cent, affects the accuracy of the results to some extent. For percentages lower than this, the effect of the silt is compensated for by the adoption of the point of maximum bulking. Most sands acceptable for concreting purposes fall within the limits stated. This being so, the relationship between bulking and surface areas has two very valuable applications in the science of concrete proportioning:

1. Knowing the surface area and the moisture content the changes in volume in the aggregate can be determined and proportions corrected accordingly.

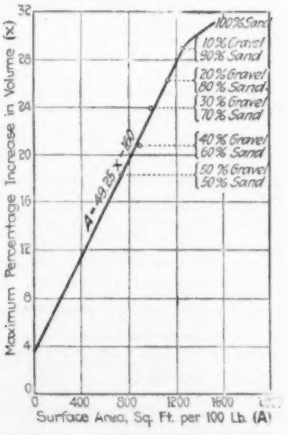


FIG. 5. SURFACE AREA—BULKING RELATION FOR MIXTURE OF SAND AND GRAVEL

2. Knowing the maximum increase in volume of a sand due to contained moisture, the surface area of that sand is at once obtainable.

While the first of these is important, it is not the subject of this paper and will not be elaborated upon. The second will be taken up at some length.

A method of obtaining the surface area of an aggregate which is both simple and rapid can be based on this relationship between the maximum bulking and surface area.

The weight per cubic foot of the sand to be tested is first determined dry and again after the addition of different percentages of moisture. The additions found to be best are four, five and six per cent of the dry weight of the aggregate; the maximum bulking usually occurring in this range, except for coarse sands free from silt when it may occur at as low as three per cent. The weight per cubic foot with the lowest percentage of moisture is first obtained; the last two percentages of moisture are then obtained by adding in each case the necessary extra water. The loss of moisture by this procedure has been found to be negligible. Applying successively Eqs. 2 and 3 to these results gives the surface area per 100 lb.

The equipment required is simple. That used by the writers consisted of a ½-cu.-ft. capacity cubical measure, a ¼-in. sieve to separate the fine and coarse aggregates, a small platform scale, and minor incidentals such as scoop, straight edge, glass graduate, etc. This apparatus may be varied somewhat to suit circumstances or the whims of the user without affecting the results.

Compared with the combined mechanical analysis and surface area calculations, the method is the acme of simplicity. It is rapid, inexpensive, requires a minimum of equipment and skill to carry out, and can be made to give accurate results.

The accompanying table shows results obtained by both methods. Here are tabulated concrete sands having, as is evident from their surface areas, a wide variation in grading. The maximum difference between their surface areas as determined by sieve analysis and grain counts and as determined by the bulking test is approximately 3.7 per cent while the average difference is only 1.77 per cent. This degree of accuracy is within the probable error of the sieve-analysis method.

COMPARISON OF RESULTS OBTAINED BY MECHANICAL ANALYSES AND BULKING METHODS OF DETERMINING SURFACE AREA OF SANDS

Sand No.	Source	Maximum Bulking, Per Cent	Surface Area Sq. Ft. Mechanical Analyses	Surface Area Sq. Ft. Maximum Bulking	Difference Sq. Ft.	Difference Per Cent
106-1	Niagara Falls, Ont.	33.1	1,515	1,524	+ 9	+ 0.59
106-2	Niagara Falls, Ont.	31.5	1,494	1,460	—34	— 2.28
106-5	Niagara Falls, Ont.	32.7	1,454	1,508	+54	+ 3.71
118	Buffalo, N. Y.	18.0	945	911	—34	— 3.60
128	Nipigon, Ont.	21.7	1,054	1,062	+ 8	+ 0.75
130	High Falls, Ont.	38.1	1,734	1,727	— 7	— 0.40
131	High Falls, Ont.	38.5	1,777	1,734	—43	— 2.42
136	Nipigon, Ont.	25.9	1,238	1,232	— 6	— 0.48
137	Nipigon, Ont.	29.2	1,324	1,366	+42	+ 3.17
141	Nipigon, Ont.	33.6	1,500	1,545	+45	+ 3.00
143	Nipigon, Ont.	40.7	1,805	1,830	+25	+ 1.39
149	Niagara Falls, Ont.	31.9	1,436	1,476	+40	+ 2.79
150	Niagara Falls, Ont.	27.4	1,256	1,292	+36	+ 2.86
154	Niagara Falls, Ont.	26.7	1,299	1,264	—35	— 2.70
155	Niagara Falls, Ont.	36.1	1,631	1,647	+16	+ 0.98
159	Niagara Falls, Ont.	29.3	1,368	1,370	+ 2	+ 0.14
161	Nipigon, Ont.	27.2	1,273	1,285	+12	+ 0.94
178	Havelock, Ont.	33.5	1,513	1,540	+27	+ 1.78
183	York, Ont.	27.3	1,304	1,289	—15	— 1.15
184	York, Ont.	49.7	2,264	2,260	— 4	— 0.17
	Average					1.765
	Coarse Sands					
106-L1	Crushed Rock	21.6	717	1,057	+ 340	+47.40
107	Niagara Falls, Ont.	28.2	1,145	1,325	+ 180	+15.72
129	Nipigon, Ont.	24.6	1,003	1,179	+ 176	+17.55
151	Niagara Falls, Ont.	23.3	866	1,126	+ 260	+30.07
	Fine Sands					
106-4	Niagara Falls, Ont.	40.6	2,079	1,828	— 251	—12.05
134	Nipigon, Ont.	40.2	2,420	1,812	— 608	—25.12
144	Nipigon, Ont.	41.3	2,446	1,857	— 589	—24.05
157	Niagara Falls, Ont.	37.9	2,888	1,719	—1,169	—40.04

The bulking test does not agree with the standard method for obtaining surface area with very coarse sands, very fine sands or with sands high in silt. This has already been touched upon. The table shows a number of such sands and the results obtained using both methods. It is thought by the authors to be extremely likely that the surface area determined by the bulking test may be a better measure of the concrete-making properties of the sand than the values obtained from the sieve analysis.

The bulking method has one weak point and that lies in its basic test—the one for the weight per cubic foot. This test is more subject to the personal equation of the operator than is the sieve analysis. It is believed that the rodding method of determining the weight per cubic foot—the method the Society is now considering for adoption as standard—would to a large extent overcome this drawback. Before the rodding test could be used it would be necessary to establish the proper equations linking surface area and maximum bulking; the equations given in this paper only hold for the methods described.

The presence of mica in a sand introduces an interesting problem. Any considerable quantity alters the specific gravity of the material (the number of grains per gram) and hence the unit areas for the different sizes of separation. These unit areas will depend to some extent on the quantity of mica present so that surface areas calculated from them do not give values comparable to similarly graded sands free from mica. The bulking test has been found to give the better value in such cases.

In conclusion, we should like to point out that the tests here presented seem to bear out the contentions of Edwards and ourselves that surface area must be taken into account in any method of proportioning concrete mixtures. It is the opinion of the authors that this bulking of particles occurs in concrete mixtures and that a study of the bulking phenomenon in concrete and its relation to grading of the aggregates as measured by their surface area will throw much light on some of our present difficulties in determining a satisfactory method of proportioning concrete.

Automatic Sewer Cleaning Outfit

Large sewers in Salt Lake City are cleaned by the machine shown in the photograph below. It is built of structural shapes and has wheels which keep the scoop from contact with the bottom of the sewer. Ropes are attached to both ends of the machine for recovery in case of any unusual obstruction. Ordinarily the sewage will carry the machine through from one manhole to the next without any pull on the rope.

SEWER CLEANING SCOOP IS PUSHED BY THE SEWAGE

The Salt Lake Sewer Department has three of these scrapers—for sewers ranging from 42 to 64 in. in diameter. They work best when the diameter of the disk is 1½ in. less than that of the sewer thus restricting the flow past it to a ⅝-in. annular space. The maintenance of sewers is under L. H. Krebs, engineer of sewers who reports to S. Q. Cannon, city engineer.

Cost of Water for Public Purposes at Rochester, N. Y.

THE total "cost" of water supplied for public use by the water-works of Rochester, N. Y., is $264,624 a year, according to figures compiled by Stephen B. Story, engineer Rochester Bureau of Municipal Research, in the course of a survey of the Water Bureau of that city. These figures were presented in some detail by Mr. Story before the convention of the American Water Works Association at Montreal, June 22 to 24, in the course of a paper on "The Revenue Chargeable to Public Uses of Water in Rochester."

As early as Jan. 1, 1877, or one year after the Rochester water-works were put into operation, J. Nelson Tubbs, chief engineer, recommended that the city pay for water the same as any private consumer would pay. Apparently it was not until 1917 that the city authorities recognized the justice of this principle and put it in partial application by crediting the Water Bureau $70,000 for water supplied to the Department of Public Works. Like credits have since been made for other city departments, but the total of the credits has reached only $126,000 thus far, compared with the $264,624 value of water actually supplied—assuming 10c. per 1,000 gal. to be a fair charge. The actual credits, Mr. Story says, are based on "guess work."

On the basis of 10c. per 1,000 gal. the water for public services passing through meters is worth $20,104.34. Unmetered water supplied for public uses, on the same basis, is worth $46,010. Rebates to charitable institutions total $15,000 and free water supplied to a school is valued at $3,000. The estimated value of the fire protection service, taking capital charges into account, is $180,510.

The accompanying table gives the estimated quantities of unmetered water supplied for public purposes, with the basis of the estimates:

ESTIMATES OF UNMETERED WATER FOR PUBLIC USE; CITY OF ROCHESTER, N. Y.

Item	Purpose	Quantity, Gal.	Cost at 10c. per 1,000 Gal.
A	Street flushing (by hand)	600,000	$60
B	Street flushing (by machine)	100,000,000	10,000
C	Street sweeping (by machine)	500,000	50
D	Street sprinkling	220,000,000	22,000
E	Sewer flushing (house laterals)	3,400,000	340
F	Sewer flushing (sewer laterals)	500,000	50
G	Sewer flushing (main sewers)	100,000	10
H	Snow removal flushing	3,000,000	300
I	Drinking Fountains	1,000,000	100
J	Horse troughs	110,000,000	11,000
K	Parks and playgrounds	20,000,000	2,000
L	Exposition park	1,000,000	100
		460,100,000	46,010

Item A. Street flushing (by hand).
Measurements of water used for hand-flushing using 2½ in. hose, 1 in. smooth nozzle. Hydrant pressure averaged 30 lb. 1,000 gal. per 1,000 sq. yd. Figures for area flushed from Street and Sewer Bureau.

Item B. Street flushing (by machine).
Six working days per week; 30 weeks per year.
Tank capacity flushed No. 1, 1,250 gal.; 29 fillings a day.
Tank capacity flushes No. 2, 1,500 gal.; 41 fillings.
Tank capacity flusher No. 3, 1,500 gal., 44 fillings.
Four wagon flushers with 60-gal. tanks, 56 fillings each per day.
Add margin for waste in filling.

Item C. Street sweeping (by machine).
Two Austin Machine Sweepers, 1,200 gal. per day, 200 working days.
Add margin for waste in filling.

Item D. Street sprinkling.
Six days per week; 30 weeks in season.
Forty tanks filled 40 times per day. Tank capacity, 750 gal. Allow margin for wastage in filling and temporary hydrant valves.

Item E. Sewer flushing (house laterals).
Sixteen hundred laterals flushed per year; 15 minutes per flushing is average time water is on. Hose and nozzle at 150 gal. per minute.

Item F. Sewer flushing (sewer laterals).
One hundred sewer laterals flushed per year: 30 minutes per flushing is average time water is on. Hose and nozzle at 150 gal. per minute.

Item G. Sewer flushing (main sewers).
Eleven sewers flushed per year. Sixty minutes per flushing is average time water is on. Hose and nozzle at 150 gal. per minute.

Item H. Snow removal flushing.
Varies yearly with amount of snow fall.
Estimate 30 days flushing at 100,000 gal. per day.

Item I. Drinking fountains.
Metered flow of fountain set up in meter shop was 25 gal. per hour. Run for five months per year. Twelve fountains of this type attached to fire hydrants around city.

Item J. Horse troughs.
Metered flow of one trough at 1,500,000 gal. per year. Seventy-five troughs operating all year in city.

Item K. Parks and playgrounds.
Estimate based on consideration of playgrounds and parks being about half metered.

Item L. Exposition Park.
Estimate well within the actual use.

Pay of Engineering Educators

Abstract of Paper by F. H. Newell, Professor, Civil Engineering, University of Illinois, Before Annual Meeting of Society for the Promotion of Engineering Education.

IN CONSIDERING adequate pay for teachers in engineering colleges it is necessary to have some base level of par value from which there may be a departure either above or below par to meet the varying conditions. This base level should be a plane of departure equivalent to the living wage upon which a man who devotes his entire time to the profession can find support for himself and his family. Reduction of the money wage below the base salary may be considered whenever, in addition to money wages, other valuable consideration is received. An increase above the base should be by stages or steps relatively small but taken at short intervals of one or two years and thereafter greater and the steps longer so as to clearly mark out the man of distinct ability.

Low rates of pay have resulted in a large proportion of instructors having to live beyond their means and necessarily going into debt. If engineering educators as a whole are underpaid the fact is due more to their lack of skill in bargaining than to the law of supply and demand. While the law of supply and demand is undoubtedly operative, its effect is largely concealed by other forces. The demand for engineering education as a commodity is reflected by the demand for graduates, since many graduates, new and untried men, are being offered more pay by prospective employers than their experienced instructors are receiving. A certain rate of pay having been acquiesced in during a long period now has an almost binding effect. The bargaining power of the individual educator must be increased and he must acquire the proper confidence in himself to drop the apologetic air of the under-valued man.

A salary schedule, embodying the base-level principle, similar to the schedule for engineering teachers reported by the committee of the American Association of Engineers at its annual meeting May 11, 1920, should be carefully considered and formally adopted by bodies representative of engineering educators and by societies of practising engineers. Such a standard is urgently needed in order that the public in general and particularly the governing boards of engineering colleges may have something by which to measure the kind of men they are getting and keeping. Without some such basis or common ground to start from all discussions of relative rates of pay become vague. By having such a standard, it may be possible to bring about a change in the attitude to the public, aided by publicity.

Engineering instructors, to be successful, must have a large measure of the spirit of self-sacrifice, and unselfish devotion for the good of their students, but they should not be compelled to seek outside employment or income from investments or depend upon the efforts of members of their families to enable them to secure a living. The public demands that the output of engineering colleges shall be of the highest possible quality, and there is not the proper confidence in the product turned out by cheap men. If there is agreement with the statement that the most critical problem in engineering today is to obtain a sufficient number of competent teachers, definite action should be taken in the matter of compensation. The promotion of engineering education becomes impossible unless these fundamentals are given proper attention. Individually, engineering educators can support the efforts of the American Association of Engineers in their behalf. Collectively, they can endorse the standards proposed by its committee. Unless definite steps are taken by engineering teachers to "speak for themselves" they cannot expect the support or sympathy of the public. By viewing the matter squarely and by taking action definitely the standard of engineering education may be raised and the object for which the Society for the Promotion of Engineering Education was formed can be carried out in the most definite manner.

Railway Water Service Organization

A COMPREHENSIVE organization for a railway water service department, proposed in a report by A. B. Pierce, engineer of water supply of the Southern Railway System, and designed as an aid in reducing water waste to a minimum, is shown in the accompanying chart. It is estimated that it would effect an annual saving of about $119,000 by checking water waste and securing more efficient operation of water stations. Special features of the plan are provisions for four inspectors and for daily reports by the pump men, these reports being compiled into monthly statements which are sent to the engineer of water supply. Stress is laid upon these two features by Mr. Pierce as he believes that few railways have such a complete system.

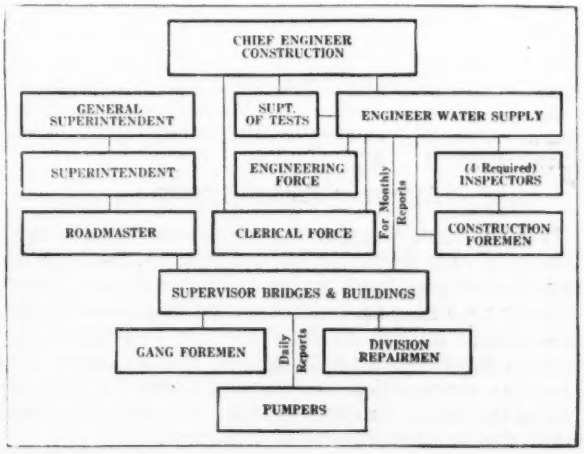


CHART OF A RAILWAY WATER DEPARTMENT

This plan differs somewhat from the one proposed by C. R. Knowles, superintendent of water service of the Illinois Central R.R., and shown in *Engineering News-Record* of April 1, 1920, p. 676. The Southern Ry. plan adds the inspectors and the daily reports but does not provide for a supervisor of water service, such a position being considered unnecessary with the proposed scheme of organization.

Notes from Foreign Fields

CONSTRUCTION METHODS IN ENGLAND

BY
E. J. Mehren
EDITOR ENGINEERING NEWS-RECORD

THUS far I have not been able to examine personally any construction jobs under way. I have, however, had the good fortune of talking to a number of British contractors and to salesmen of American construction machinery.

We are sometimes told in America that the British contractor uses antiquated methods and is not open to conviction regarding the labor-saving devices developed in the United States for construction work. What I have learned can be summed up in this sentence: Had the British contractor been faced ten or fifteen years ago with the high prices of labor that then prevailed in the United States (and that now prevail in Great Britain), he would have been using just as much machinery as the American contractor is using today.

In other words, the British contractor is wide awake. He knows how to figure a job closely. He knows that labor-saving machinery, competently operated, will reduce construction costs when wages are high. *When wages are high*—that is the crux of the situation, the reason for the difference between British and American construction methods. Before the war *good* construction labor could be secured in Great Britain for seven pence an hour (about fourteen cents of our money, under the pre-war rate of exchange) and with labor—good labor—at that figure we must admit that the use of expensive labor-saving machinery would not be justified. Today, conditions are quite different. Wages have more than trebled and the efficiency is only 50 per cent of what it was. Pick and shovel men now get 2s.1d., or about 50 cents an hour. The British contractor is, therefore, rapidly turning to labor-saving construction machinery.

American Plant Favored

It is apparent, too, that the wide-awake British contractor is very favorably impressed with the type of construction machinery we make in the States. Particularly did I hear favorable comment on the sturdiness with which we are building our construction plant. Such is the demand for it indeed, that an agent for American construction machinery assured me that if he had ten times the amount he is now receiving from the States he could dispose of it at once.

Another indication of what is coming in Great Britain is that English manufacturers are beginning to build types of plant developed in America but hitherto neither built nor used in the United Kingdom. Several firms are putting out their first light revolving steam shovel—on the order of the Thew and the Erie—while one company has completed its first trench digger. The designs are said to copy ours very closely.

One is safe in predicting, therefore, a new era in construction methods in Great Britain. Necessity is a great accelerator, and while so far only the larger contractors are using the American type of devices hitherto not used here, the smaller contractors are certain to follow rapidly.

Vehicular Tunnel Under Thames

Due to the interest now displayed at New York in the proposal to put a vehicular tunnel under the Hudson River, I was very much interested in walking through one of the vehicular tunnels under the Thames—the Rotherhithe Tunnel—a tube 30 ft. in external diameter, with a 16-ft. roadway and two footways, each about 4½ ft. wide. The roadway, under the stream itself, is some 70 ft. below the pavement level at the surface and the grades are less than 3 per cent. On the north side of the river, from which we entered, there are two ventilating shafts and in the tunnel as a whole the greater distance between shafts is about a quarter of a mile.

No restriction is placed upon the type of vehicle that may use the tunnel. We saw horse-drawn carts and wagons of many descriptions, both steam and gasoline-propelled motor trucks and one passenger automobile. The tunnel was not operated anywhere near capacity. There were long gaps in both lines of traffic, so that the speedier vehicles had no difficulty in passing the slower ones.

The roadway is paved with granite blocks, the edges of which are fairly well worn, so that owing to the large amount of horse-drawn steel-tired traffic it was extremely noisy. One had to shout to make himself understood. The atmosphere also was unpleasant, due probably both to the exhausts from the motor trucks and from the dust raised by the vehicles.

My guide said that the installation of a ventilating system had been frequently discussed, but so far no plans had been matured. The use of the tunnel would certainly be far more agreeable with an adequate ventilation system and this brief experience at Rotherhithe was indicative of the wisdom of the engineers of the proposed Hudson vehicular tunnel in laying such great emphasis on the ventilation problem. Here, with a distance of only about a quarter of a mile between shafts, the conditions in the tunnel were far from agreeable. More annoying than the smoke and dust was the noise. From the noise, I assume, we should be practically free at New York, because there would probably be a very small proportion of horse-drawn traffic. Certainly more than 50 per cent of the traffic through Rotherhithe, when we were there at 3 o'clock on a Thursday afternoon, was horse-drawn and steel-tired. As to the ventilation, though, the difficulties at New York would be much greater, both because of the greater distance and the expected constant streams of motor vehicles between shore shafts.

London, May 15, 1920.

Plan for Financing Milwaukee Water Filters

To finance the proposed new water filtration plant for Milwaukee—the city being up to its debt limit—Henry P. Bowman, superintendent, has recommended that the meter rates be increased by 40 per cent and that a $2 service charge be established, the latter to be continued after the filters are completed to meet operating costs. The present meter rates would be restored at the end of five years. The meter rates are now 6c. per 1,000 gal. in all consumers and there is neither service charge or minimum rate.

Education of the Highway Engineer

Extracts From Paper Read by Brig. Gen. C. H. Mitchell at Seventh Annual Canadian Good Roads Congress, Winnipeg, June 1-3.

WE naturally think of highway work as a branch of the broad subject of civil engineering, and so it is. But when one considers at length the various features involved not only in the actual road building but the closely related problems which accompany it, it is found that, as an engineering question the so called specialty embraces many features of other branches of engineering, such as mechanical, chemical and even electrical, with all of which the well informed and broadly trained highway engineer should have no small acquaintance.

It is not sufficient that the civil engineer engaged in highway construction should have a good experience and ability in land survey work, topography, cross sectioning or mapping, or skill in the location and the balancing and computation of quantities involved in excavations and embankments or in grades and drainage or in foundations or aptitude for the patient and laborious attention to office detail which goes with a well organized engineering staff. But he must also have a degree of experience in design and construction, perhaps even to the extent of being an expert in steel and concrete bridges and culverts, in retaining walls and those many concrete structures incidental to roads of all classes. To consider the subject broadly he must be also a student of meteorology and understand the climatic conditions and their effects and he must know something of geology and even of petrology where so concerned with the qualities of road metals. If he is concerned with paving roads and streets in closely settled areas he has a highly specialized field before him in the study of the sources, properties, preparation, construction, behavior and maintenance of all kinds of paving materials from gravel and stone to wood and asphalt. But that is not all for he must be prepared at all times, where building such roads and streets, to deal with the continuously occurring problems involved in taking care of water pipes and sewers, of street railway tracks, of railway crossings and their protection and operation and of the increasingly difficult electric line crossings whether telegraph, telephone or high tension electric power lines.

Must Have Large Professional Talents

But the engineer in this work, if he is to be really up to it, must be more than a civil engineer for, as pointed out he must have a knowledge of mechanical and electrical and chemical work as well to follow the present day progress. Not only must he be conversant with the underlying principles of traction but he must have a practical working knowledge of the mechanical and electrical machinery and equipment used in the processes of manufacture and preparation of materials and in the construction of roads. The varieties of such equipment, with the machinery for instance of handling materials in excavation, quarries, sand and gravel pits, and in the preparation of them by crushers and screens or the machinery used in construction, concrete mixers, road rollers, asphalt, tar and similar plants are in themselves such important factors in road building as to demand close attention and knowledge on the part of the engineers. But there is the other phase of the mechanical of which the road engineer of today must have more than a passing knowledge. He must know the various principles of operation and control of motor transport of all kinds from the touring motor car to the freight lorry and their effect upon his roads in all seasons and with the activities of the manufacturers of today he must also keep up with the rapidly changing types of steam, oil and electric vehicles.

The co-ordination necessary for electrical work in connection with streets and highways has already been indicated as to line crossings but it is no small matter in congested areas to deal with the complicated problems of electrical conduits in the road bed, overhead wires, electric lighting arrangements and the vexed questions of electric railway and their maintenance with regard to the road bed.

So with the chemical side of the work. There must be for the future a large proportion of these engineers engaged in or with a knowledge of the chemical properties of the various soils and materials of road construction and of the chemical processes involved in securing, preparing and applying in construction, the various special constituents of tar, asphalt and other materials.

Another feature, which in this new country is now very properly claiming attention in highway construction is that concerned with the strategical planning of routes either municipal or provincial and the work of general design related to the broad principles of town planning. Much is to be made and is being made of this feature and it is very desirable that the coming engineering generation should make it a part of their work of preparation. In doing this they should not lose sight of the artistic and æsthetic in their work of street arrangement and beautifying, in their boulevards and parkways and even in the long reaches of rural highways which are so attractive a feature in the roads of England and France, of which the soldiers in the war have pleasant memories.

Business Attainments Necessary

But engineering and technical knowledge and experience is not all that the successful highway engineer of today and tomorrow will require. That will be only a part of his professional equipment. He must be much more than a technical man. The nature of this work requires much other knowledge and many other qualifications. He must have administrative ability, he must have vision, judgment and tact and those most vital qualities which will enable him to deal with and co-operate with other men whether workmen or employers, foremen or contractors, sales-agents or walking delegates, business men, ratepayers or politicians. For after all the business of the building and maintaining of highways today is largely business, administrative work with engineering closely mixed with it and as we go on in our complex methods of doing things the business and the engineering will become more interconnected and inseparable. The highway engineer must therefore equally, be an administrator, an economist and a co-operator with the business man, the legislator and the ratepayer..

Now, how are we going to secure these engineers? It will be said we ask for a super-engineer.

The responsibility lies not so much on schools, colleges or universities as upon the municipalities and the governments who are building roads and highways. True, the colleges and universities must give the fundamental education, but it is quite evident that the further or later education must progress in successive stages in the field, on the actual construction or in the engineering or administrative offices of highway departments or commissions of the country.

Track Flangeways and Car Wheel Flanges

Increasing the section of flanges of cast-iron car wheels, as suggested by wheel manufacturers, is unnecessary in the opinion of the wheel committee of the mechanical section of the American Railroad Association. The track committee of the American Railway Engineering Association has expressed the opinion that the flanges can be increased without requiring any difference in width of flangeways at frogs and crossings and without changing the present method of track construction. On the other hand, the wheel committee considers that a change in section is inadvisable and that neither safety nor economy will be served by adding material to the flange in such location as will affect track clearances. In this respect the committee stands by its report of 1916. Some roads are using wheels with flanges thicker than the standard section, and others are using wheels in which the flanges are thicker at the base line, or at the tread, but track clearances are not affected.

LETTERS TO THE EDITOR

Is the Workman Responsible for the Present High Labor Costs?

Sir—In the article, "Is the Workman Responsible for High Labor Cost?" published on p. 876 of April 29, I find two corrections necessary:

1. In the tabulation on p. 877 under "masons," the per cent increase in wages should read 38.5 to 54 instead of 38.5 to 24. This is apparently a typographical error.

2. Just before the above mentioned table the index number for 1914 should be 99 instead of 132. The figure 132 was given to me in error, and the error was discovered when I made some additional studies from the original figures of the Department of Labor. The per cent increase in commodity prices should be 108 per cent instead of 50 per cent. This strengthens the argument and shows that the tradesman has been relatively falling behind in spite of high wage rates.

DAN PATCH.
Boston, Mass. Aberthaw Construction Co.

Development of the Professional Spirit in Engineering Education

Sir—While methods of conducting large business enterprises have been developed along scientific lines, with few exceptions, educational methods are for the most part archaic and inefficient. Dr. Mann's article in *Engineering News-Record*, June 24, p. 1242, is inspirational and should materially assist in developing new ideas and ideals. The aim and the spirit of education should be service, and the development of the mind and the soul of the engineering student are equally important.

One difficulty in teaching engineering students is to obtain efficient and competent teachers. Young men are ever ready to follow a leader and the best method of developing the student is to have him come in intimate contact with teachers who are not only well educated and trained, but who are men with a heart and a soul; men who have the ability to develop in the student a desire to reach a position where he can be of service and to develop into a man of the highest type as well as an efficient engineer.

If the technical courses are developed along efficient lines, there will remain, even in the four-year engineering course, sufficient time to give courses in economics, business law, human relations and engineering administration. These courses should be conducted by men who have had a wide experience and who can impress themselves on the student. While researches such as outlined by Dr. Mann are valuable if they are directed by comeptent men, the results are very certain to be unsatisfactory if the teacher in charge is lacking in training and the ability to direct. The most important factor in engineering education is the teacher. It is at present very difficult to get well trained men to teach; and the call of business is taking away from the teaching profession many of our really efficient teachers of engineering. If the profession of engineering is to attain its right place, the position of the engineering teacher must be made more attractive. With able engineering teachers the details of instruction are not so material; with mediocre teachers, all methods will fail. MILO S. KETCHUM,
Professor in Charge of Civil Engineering,
Philadelphia. University of Pennsylvania.

Sir—Replying to your letter of June 17 I endorse the point made by Dr. C. R. Mann, in his article in *Engineering News-Record*, June 24, p. 1242, that the spirit of service should be inculcated earnestly in all engineering students by all engineering schools. This is nothing new but has long been recognized by engineering schools, as was proved very conclusively by the way in which the engineers of the country responded when the United States entered the World War. If the writer of this letter had felt inclined to think that his own action in sacrificing $1500 per year salary and all certainty of future permanency of employment in the position he had held for twenty-six years to enter the Army was unusual in an engineering educator (which it was not) he certainly would have been disillusioned when he ran across so many other engineering educators in the service who had done practically the same without making any ado over such action whatsoever. The thousands upon thousands of practising engineers who thronged into the Army proved they had already been taught the true spirit of service at the engineering colleges by their deeds, not by words.

I realize that general pronouncements such as that of Dr. Mann on this subject are needed from time to time to keep our ideals ever before us. Just now, however, the most important thing in connection with teaching the spirit of public service is the devising and adoption of definite measures to instruct our engineering students in the great engineering and public movements of the day and the duty of engineers to participate therein effectively, personally and through strong local and national organizations, safeguarding the public and the engineering profession by the adoption of definite professional codes of ethics, by administering swift justice to those who violate professionl ethics, and by securing the passage of just and adequate engineers' license laws. ANSON MARSTON,
Dean, Division of Engineering, Iowa State College.
Ames, Ia.

Engineering Foundation and An American Hydraulic Laboratory

Sir—Certainly there are many useful contributions to hydraulic engineering and the underlying science which can be made only by a well supported laboratory, as indicated in the statements of Clemens Herschel and the editorial in *Engineering News-Record*, June 24. Problems relating to power development, water supply, irrigation, sewerage and other practical applications of hydraulics, await solution in such a laboratory through the work of competent experimenters.

One element in the present situation in America, mentioned in your journal, should be brought much more prominently to the attention of engineers and the industries. There exists in Engineering Foundation, organized by four of the leading national engineering socities, on the basis of the generous gift of Ambrose Swasey as the nucleus of a large endowment fund "for the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind," the instrumentality for bringing into existence such a laboratory as is suggested. Engineering Foundation supported Mr. Herschel in his experiments on weirs to the limit of its small resources. The Foundation is thoroughly competent to receive and administer endowment funds in any amount, including those especially designated for an American Hydraulic Laboratory. Furthermore, the Engineering Foundation Board could undertake the establishment and management of such a laboratory and could publish, through the journals of its supporting societies and its own bulletins, the results of the experimental work.

You were recently good enough to make known to your readers Engineering Foundation's endeavors to secure larger endowment. Will you not now bring to their attention this specific possibility in which the readiness-to-serve of the engineering societies through Engineering Foundation, the needs of the profession and the industry, and the farsighted generosity of individuals and corporations can be brought together for the advancement of the profession and the good of mankind?

ALFRED D. FLINN,
Secretary The Engineering Foundation.
New York City.

HINTS FOR THE CONTRACTOR

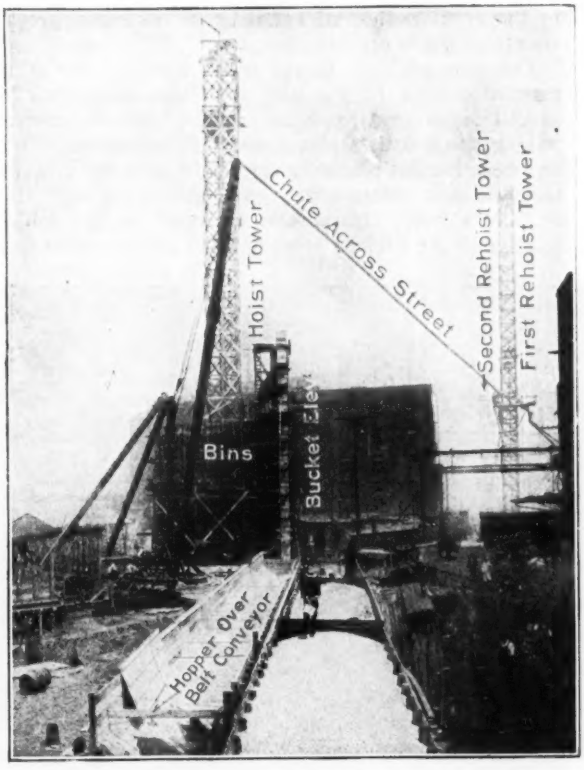
DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Concrete Building Plant Plans—I

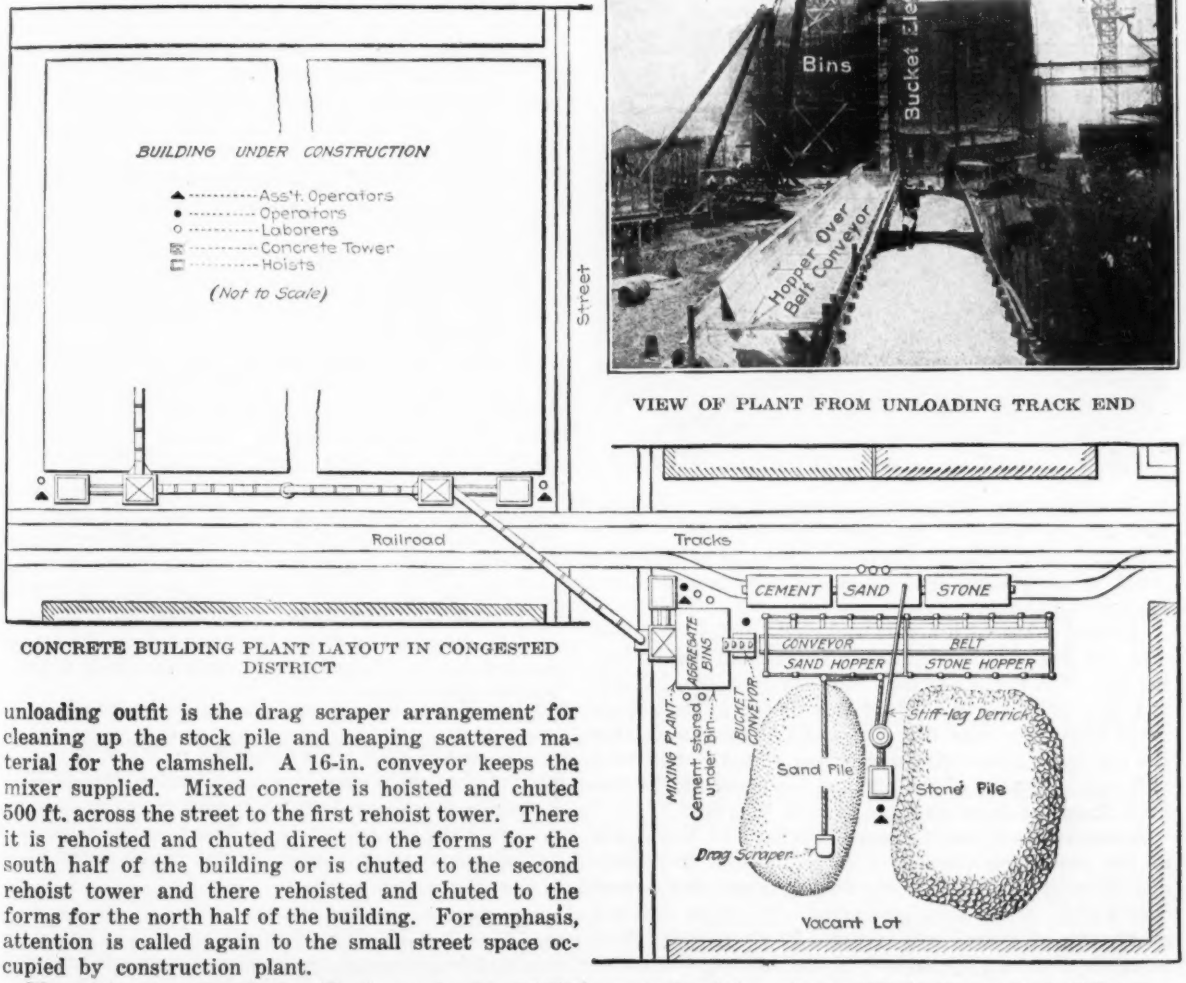
Across-Street Vacant Lot Keeps Plant Off Congested Street

BY SPOUTING diagonally across intersecting streets and using two rehoist towers, it is possible, with a concrete plant located in an adjacent vacant lot, to distribute concrete for an eight-story building, 357 x 131 ft. and leave the streets unobstructed by equipment except for the sidewalk space on one side of the building. The illustrations show the plant layout and the distribution of the operating force.

All parts of the plant are balanced with respect to the 28 cu.ft. mixer. A ¾-cu.yd. clamshell meets the unloading requirements. The one special feature of the unloading outfit is the drag scraper arrangement for cleaning up the stock pile and heaping scattered material for the clamshell. A 16-in. conveyor keeps the mixer supplied. Mixed concrete is hoisted and chuted 500 ft. across the street to the first rehoist tower. There it is rehoisted and chuted direct to the forms for the south half of the building or is chuted to the second rehoist tower and there rehoisted and chuted to the forms for the north half of the building. For emphasis, attention is called again to the small street space occupied by construction plant.



VIEW OF PLANT FROM UNLOADING TRACK END



CONCRETE BUILDING PLANT LAYOUT IN CONGESTED DISTRICT

The main concrete plant will place only the 18,000 cu.yd. of concrete in the main building superstructure. It was found more economical to put in footings and pedestals, in which the daily volume of concrete required was small and widely distributed, with a number of portable 7-cu.ft. mixers, instead of operating the central mixing plant. When the main building concrete is placed these small mixers will be again used to construct walks, curbs, platforms, etc.

The building is being constructed in the stock yards district of Chicago for Morris & Co., by R. C. Wieboldt, general contractor, Chicago.

Handling Aggregate with a Drag Scraper

By Henry W. Walter
Niagara Falls, N. Y.

During the recent construction of a concrete factory building for the Shredded Wheat Co., at Niagara Falls, N. Y., lack of storage space near the concrete mixer led to the novel method of handling the coarse aggregate shown in the accompanying view.

The new addition to the plant occupied the entire remaining area of the plot with the exception of a small triangular strip at the front. After the concrete mixing and hoisting plants, cement storage sheds, etc., had been located on this strip, the remaining area was insufficient to insure a storage of gravel for more than one day's run. Gravel was delivered to the job by truck, and for various reasons could not be relied upon

to be continuous. Wheeling in barrows was impossible due to the scarcity and high cost of labor. Some method was necessary whereby a relatively high pile could be maintained and placed as close to the mixer hopper as possible.

A wooden bin with a gate and chute at its lower end was constructed immediately in front of the mixer hopper. The chute was hinged at the gate in order that it might be raised out of the way of the mixer hopper when the latter was being elevated to discharge into the mixer. Timber wing-walls were spiked to the sides and rear at the top of the bin, and the plank incline was built from the front down to the pile of gravel.

A snatch-block was fastened overhead to the frame of the concreting tower. A cable through this block and through one lower down on the tower was passed over a drum of the hoisting engine. The other end, out on the pile of gravel, was fastened to an ordinary drag scraper. Between operations of the bucket, the hoistman operated the scraper.

Incoming gravel was dumped at the foot of this incline, and spread out fan-shape from it to the street line. Two men were required at the scraper to guide it into the pile and to overhaul the cable when pulling it back. A third man, stationed at the hopper bin, signalled the hoistman and also helped with the overhauling. These three men, together with two others whose duty it was to level the pile in the mixer hopper and to carry cement, comprised the entire force operating at the raw material end.

No capital was tied up in this plant which was built out of materials at hand, and yet, supplying a 14 cu. ft. mixer, 125 cu. yd. of concrete have been placed during a ten-hour day. The men at the scraper worked steadily but were not crowded to accomplish this.

By means of the bin grate and a marked mixer hopper it was found that a more constant mix was obtained than possible with barrows and shovels.

The erection of the new addition is being done by the John W. Cowper Co. of Buffalo, N. Y. The work is under the direction of Walter McCulloh, consulting engineer for The Shredded Wheat Co. The solution of the aggregate handling problem is due to J. P. Doyle, superintendent for the contractor.

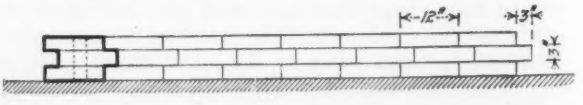
Large Cable "Trollied" Over Towers

USING ⅝-in. wire ropes as trolley cables, two 1¼-in. chute-suspension cables, 1,000 ft. and 1,200 ft. long, respectively, were successfully installed on high towers at the Bunte factory under construction in Chicago by R. C. Wieboldt, general contractor. The suspension cables cross on an angle of about 60 deg. at a double hoist tower 230 ft. high. One cable spans the 230-ft. main tower and a 150-ft. auxiliary tower, between deadmen 1189 ft. apart. A low support tower at each end, where the cable slants down to the deadmen, holds the cable clear of crossing streets. The other cable spans the main tower, an auxiliary tower 180 ft. high and a rehoist tower 180 ft. high. At one end a support tower keeps the stretch from main tower to deadmen clear of railway tracks.

To erect each cable, a ¾-in. manila line was taken over the towers and was used to pull a ⅝-in. steel cable from deadman to deadman over the towers. This cable was used to "trolley" over the 1¼-in. cable. When in place the main cable was tightened by 2½-in. guy tighteners at each end. The trolley cable was left in place alongside the main cable to be used in taking it down. At the towers the main cable rides on a roller consisting of a 2-in. pin journaled in two steel angles about 1 ft. long attached to proper timber supports. When the main cable had been strung and pulled taut, the blocks used to support the chutes were spaced on a ¾-in. line and fed out on the main cable from the main tower to the auxiliary towers.

Sheeting Spiked Like Flooring

IN fabricating Wakefield sheet piles for Pier B of the Seattle, Wash., port works, large output was secured by laying the component 12- x 3-in. planks as indicated by the sketch and then spiking them in one operation as,



ordinarily, flooring is spiked. Wire spikes 9 x ⅛ in. were driven staggered every 12 in. When driving was completed the piles were separated and turned over and the points of the spikes were clinched. The large platform necessary for the operation was provided by the pier deck.

NEWS OF THE WEEK

New York, July 8, 1920

Duties of New Water-Power Commission Outlined

Personnel Partly Decided On and Prospective Work Abstracted From Bill As Signed

Proceeding on the assumption that the Water-Power Act, as signed subsequent to the adjournment of Congress, is now law, the President has designated the Secretary of War as chairman of the Federal Power Commission formed by the law.

The technical work which will be required of the Water Power Commission under the terms of the act is as follows:

Engineering:

General investigation of electrical power industry.

General investigation of water-power sites, and estimates of cost of development.

Estimates of amount and value of power available at Government dams.

Examinations, cost estimates and reports to Congress on projects recommended for construction by the United States.

Examination, cost estimates and reports to Congress on projects for which it is recommended that the cost of navigation facilities be supplied in whole or in part by the United States.

Preparation of comprehensive plans for development for all purposes of streams and stream systems upon which applications for licenses are made.

Passing upon construction plans proposed by licensees.

Physical valuation of properties in rate making proceedings.

Determination of necessary repairs required for maintaining projects in effective operating condition.

Determination of adequate depreciation reserves upon property.

Determination of operating rules necessary for protection of life, health and property.

Report on Great Falls power project near Washington.

Report on District of Columbia water-supply.

Accounting and Statistical:

Preparation of a system of uniform accounts.

Preparation of forms of reports and inspections and checking of such reports.

Examination of books and accounts of licensees.

(Continued on p. 92)

General Gorgas Dead

Major-General William C. Gorgas, former Surgeon-General, U. S. Army, died, July 4, in London, where he had gone a few weeks previously preparatory to a mission to West Africa in behalf of the British Government to investigate sanitary conditions. General Gorgas was born in Mobile, Ala., in 1854. He graduated, with the degree of A. B., from the University of the South, at Sewanee, Tenn., and studied medicine at Bellevue Medical College, New York City. In 1880 he was appointed Surgeon, U. S. Army, and was subsequently made Captain, Assistant Surgeon in 1885, Major, Brigade Surgeon and Major, Surgeon in 1898, and Colonel, Assistant Surgeon-General in 1903. During the Spanish-American War, while in charge of the yellow fever wards of the hospital in Havana, and in the years which immediately followed it, as chief sanitary officer of Havana, General Gorgas applied methods of combating yellow fever which eliminated that disease from the city.

In 1905 he was selected by the U. S. Government as chief sanitary engineer of the Panama Canal, and practically removed from the Isthmus the diseases of malaria and yellow fever, which had twice defeated the French canal builders, and made healthful the area surrounding the present canal. In five years' time he made a tremendous reduction in the yellow fever rate. General Gorgas was the author of "Sanitation in Panama," (reviewed in this journal Nov. 18, 1915), which deals with his conquest of yellow fever at Havana and Panama. In 1913 he went to South Africa for the British Government to investigate conditions in the Rand Mines, where epidemics of pneumonia raged. He received his appointment in 1914 as Surgeon-General, with the rank of Brigadier-General, and the next year was made Major-General, Surgeon General, U. S. Army. As a permanent director of the International Health Board of the Rockefeller Foundation, he also recently stamped out yellow fever at Guayaquil, Ecuador.

New Officers of Research Council

Election of officers of the National Research Council for the year beginning with July, 1920, resulted in the choice of the following: Chairman, H. A. Bumstead, Yale University; vice-chairman, C. D. Wolcott, Smithsonian Institution; Gano Dunn, New York, and R. A. Millikan, University of Chicago; Secretary, Vernon Kellogg, Stanford University; Treasurer, F. L. Ransome.

Engineering Educators Discuss Co-operation

Relations Between College and Industry Main Theme at Meeting of Society for Promotion of Engineering Education

Throughout the 28th annual meeting of the Society for the Promotion of Engineering Education at the University of Michigan, Ann Arbor, June 29 to July 2, ran the theme of the interdependence and co-operation of the engineering colleges with industry. Co-operation with engineering societies and engineering English also received much attention. The mechanical and electrical engineers intimately connected with industry were much in evidence at the meeting, while the civil engineers modestly put through a series of "principles which should be considered in planning and administering the structural courses of a curriculum in civil engineering." Results of intelligence tests for accelerating the early removal of the unqualified were given as a progress report only. One sensed the reassuring feeling that the engineering educators are distinctly aware of the great economic changes in the country's needs, due to the passing of pioneer development of natural resources to a more intensive industrialism. The professors, however, were more specific and practical than the above generality would indicate.

The sessions were opened by papers of decidedly practical import, "Co-operation Between Industry and Education," by R. D. Chapin, president, Hudson Motor Car Co., and S. P. Capen, director, American Council on Education. Mr. Chapin made a plea for more intensive training in the fundamentals, followed by specialization in direct connection with the industries. He indicated the excessive demands for highway engineers who particularly needed the broadening influences of the general courses.

What M. I. T. Is Doing

Examples of co-operative education were given by H. B. Shaw, Doherty Co.; C. S. Coler, Westinghouse Electric & Manufacturing Co., and Prof. W. H. Trimbie, Massachusetts Institute of Technology. The latter described the five-year electrical course given in connection with the General Electric Co. at Lynn, Mass. While the most striking difference between this course and other co-operative courses is in the length of periods, 13 weeks in the shop, 11 in school and 2 weeks' vacation, the main endeavor is to develop a student's mind, character and body, and at the same time inculcate in him a spirit of loyalty.

Ira N. Hollis, president, Worcester Polytechnic Institute and past-president, American Society of Mechanical Engineers, opened the discussion on co-operation with the engineering societies. He was of the opinion that the formation of chapters in the schools by the individual societies is too narrowing for the student. All national societies should join in forming single all-embracing undergraduate societies. He considers the societies as post-graduate organizations and he held that the founder societies must take their fair share in supplementing the education already given. Both Dr. Hollis and Dean M. E. Cooley, University of Michigan, instanced the success of the general student society and the subsequent failure of the specialized organization.

Dr. F. H. Newell, in discussing another paper, called attention to the numerous chapters being formed by the American Association of Engineers, an all-inclusive organization. Dean Cooley held that the co-operative endeavor of the national societies so far was largely selfish and designed to increase the future membership roll. In his opinion the national societies should concern themselves with uniform entrance and graduation requirements, with content of courses, particularly when longer than four years, with the difference between professional engineers and technicians and with financial and administrative problems of research.

Prof. J. H. Dunlap, State University of Iowa, gave some startling figures indicating the relative positions of the professions of medicine and engineering with reference to graduation requirements. Twenty years ago only 14 per cent of the medical schools required for admission more than a one-year high school course, as compared with the requirements of 33 per cent of the law schools and 80 per cent of the enginering schools. Moreover, 91 per cent of the medical schools had a four-year, 28-months, course, as compared with 98 per cent of the engineering schools having a 35-months course. The law course was much briefer than either of the other two professions. Today the medical schools are at the top, the law schools in a middle position and the engineering schools at the bottom of the list. Prof. Dunlap suggested that the society appoint a committee on a model or standard engineering curriculum to co-operate with a similar committee of Engineering Council.

Much pent-up animosity was evident during the discussion on experiment station legislation. Charles S. Howe, president, Case School of Applied Science, Cleveland, is head of a committee on the subject. He wanted light, wanted constructive criticism, but it was apparent that the fight between the land-grant colleges and the state universities for federal aid was not to be aired in this convention. President Howe wanted to know of some congressional bill to support. The factions are in an uncompromising attitude and the land grant adherents particularly preferred not to discuss the matter. Dean W. G. Raymond, State University of Iowa, presented a bill, now in the course of preparation, which will provide for apportionment by the executive committee of the National Research Council of federal funds for research to that institution, public or private, which has a problem worthy of solution. Dean F. L. Bishop, University of Pittsburgh, made a general plea for funds for research. He is now engaged on an investigation for a corporation costing $500,000. Much of the information developed should be public property but will necessarily be retained in the private files of the corporation. A resolution endorsing the principle of federal and state aid fathered by Prof. W. T. Magruder, Ohio State University, was endorsed. Later A. L. Williston, principal, Wentworth Institute, Boston, got endorsement of a resolution calling on the committee to harmonize the various plans and, if not able to do so, to bring in a bill of its own drafting.

No Action on Pay

"The Pay of Engineering Educators" was the title of a paper by Dr. F. H. Newell, University of Illinois, which received a surprisingly small amount of discussion and no action. Prof. C. J. Tilden, Yale University, chairman, American Association of Engineers' committee on salaries of engineering educators, indicated almost unanimous response from the heads of the engineering colleges to whom the preliminary report has been submitted with a request for comment and acceptance as corresponding member of the committee. Dean Bishop held that the revision of salaries proposed was based on a fallacy because it assumed that the salaries in 1912-14 were adequate and that the attempt was made to revise them in accordance with the comparative purchasing power of the dollar then and now. President Howe agreed with the schedule proposed but held that the existing scales were high for the instructors "we now have to take." Since the schedule is tentative no action was asked for.

The 1921 meeting of the society will be held at Yale University, New Haven, Conn., June 28, 29 and 30. The newly elected officers are as follows: President, Dean M. E. Cooley, University of Michigan; vice-presidents, Dean T. U. Taylor, University of Texas, and Dean H. S. Evans, University of Colorado; secretary, Dean F. L. Bishop, University of Pittsburgh; treasurer, W. O. Wiley, John Wiley & Sons.

Montreal Now Accepts Liberty Bonds from Contractors

Instead of the personal certified check of 10 per cent of the bid, Montreal contractors are now allowed to submit a victory bond or a City of Montreal bond, when they have been awarded contract for construction of municipal public works.

Highway Work in Southern States Faces Demoralization

Highway work in southern states has been severely affected by the recent ruling of the Interstate Commerce Commission giving the coal industry priority on open top cars, according to information received from several sources. As a result of the commission's ruling that railroads must distribute available coal cars for loading coal to a minimum of 50 per cent of actual requirements before using coal cars for loading other commodities, not a few southern contractors have had their material supplies cut off. So serious has the situation become that in Georgia, Virginia, and North Carolina highway work is threatened with almost complete discontinuance and highway commissions with disorganization.

Not only are state highway commissions affected, but city paving in many southern municipalities has slowed up. Immediately upon the publication of the commission's order, W. R. Neel, State Highway Engineer of Georgia, issued a circular letter to all contractors in which he requested information as to tonnage of materials necessary to complete contracts being executed with the state highway department and counties of Georgia. Contractors were asked to state points of origin of shipments and requested to send the information in as quickly as possible. Frank Page, chairman of North Carolina Highway Commission, requested the Interstate Commerce Commission to amend the embargo order so that coal cars entering the southern territory might be used for one trip between quarries and highways before shipping them back to the coal mines.

Although the Commission's order is effective only for thirty days, ending July 21, it is pointed out that those thirty days are ideal for highway construction, and also that if contractors and highway department organizations are disrupted in the embargo period it will be difficult to rebuild organization forces after the material shipments again pick up.

Water Power Commission

(Continued from p. 91)

Accounting in connection with regulation of rates, service and securities.

General technical statistical work.

Annual report to Congress.

Legal:

Preparation of rules and regulations.

Passing upon legal phases of licensees.

Legal questions in connection with regulation of rates, service and securities.

Legal questions in connection with the Federal and State statutes applicable to the work of the commission.

Seek Change in Road Bond Interest Rate By Initiative Measure

Before July 14, 75,000 signatures must be obtained to place upon the ballot in California an initiative petition to change the interest rate on remaining state highway bonds to a rate which will make them salable, and also to relieve the counties of the payment of state highway bond interest after July 1, 1921. Under the initiative measure a board, composed of the governor and other state officers, and serving without compensation, is created to fix the interest to be paid from time to time to meet market conditions, but never in excess of 6 per cent.

This initiative measure is necessary if highway work is not to stop for an indefinite period, says a recent bulletin issued by the California Highway Commission, and if counties are to be relieved of the state highway bond interest burden.

The Committee of Twenty-one, which had charge of the campaign for the flotation of the $40,000,000 road bond issue, representing the recently held state-wide conference, which on June 19 unanimously proposed to back such a proposal for relieving the highway situation, met in San Francisco, June 29, and appointed a committee to direct the campaign for signatures. On this committee are Senator Johnson, chairman; Burton A. Towne, secretary; James O'Brien, of Marysville; A. S. Dudley, of Los Angeles, and Richard Welsh, of San Francisco. The committee, accepting the draft of the initiative as prepared by Attorney General Webb, will call upon chambers of commerce, boards of supervisors, farm bureaus and citizens interested in the continuation of state highway construction in California, to circulate the petition and secure the signatures necessary to place the initiative measure upon the ballot at the November election.

Salary Increase Authorized for New York Subway Engineers

The second $300 a year increase in salary for all engineers employed by the Transit Construction Commission of New York City who are receiving $3300 per annum or less was authorized on the 25th of June when the Board of Estimate approved the budget of the Transit Construction Commission, after the strong solicitation of the New York Chapter of the American Association of Engineers.

The same estimate carried an increase of 15 per cent for all inspectors.

The former increase of $300 per annum was granted at the end of 1919, when after considerable preliminary efforts, the representatives of the American Association of Engineers at the meeting of the Board of Estimate on December 3 prevailed upon the board members to not adjourn without adopting the budget to provide for salaries of all of the engineers employed by the commission and which carried with it a provision for a $300 increase.

Detroit Grade Crossing Program

As part of the general plan of eliminating grade crossings at Detroit, the Michigan Central R.R., New York Central R.R. and the Wabash R.R. will commence work on track elevation this season at Livernois Ave., Dix Ave. and Waterman Ave. In conjunction with this improvement, the city will open and extend Military Ave. across the right-of-way of these railways and will construct a subway under the tracks. The latter work will be done wholly at the expense of the city. Track depression is advocated by the city for the De Quindre St. line of the Grand Trunk Ry., but though the case was presented to the State Railroad Commission in 1917 no decision has been rendered. The scheme for complete elimination of grade crossings has been prepared under the Department of Public Works by the division of grade separation, of which John W. Reid is engineer. (See *Engineering News-Record*, March 13, 1919, p. 511). In a recent number of the *Detroit Motor News* Mr. Reed calls attention to industrial districts where costly plant investments are being made without provision for future removal of tracks from the street surface.

Federal Officials Organize

More than a hundred members of the government service who are in responsible administrative and technical positions met June 17 and perfected a tentative organization which is to be known as The Federal Club. Its purpose is to care for many of the problems of the service common to several departments by the interchange of views, and where appropriate, by joint action. Assistant Secretary of the Navy, Franklin D. Roosevelt, is the chairman of the temporary body and Dr. E. B. Rosa, chief physicist of the Bureau of Standards, is chairman of the committee on organization and constitution.

County Unit Road Bond Petitions Are Many in Indiana

Proposals by Indiana counties to build between $40,000,000 and $60,000,000 of roads under the county unit road law are either now before the state board of tax commissioners or will be laid before the board if it will indicate that it will approve any county unit road bond issue petitions, according to Fred A. Sims, chairman of the Indiana board of tax commissioners. This road building is exclusive of the road building program outlined by the state highway commission. Mr. Sims said the board will approve no county unit road law bond issues until after the special session of the legislature. He said if the legislature does not change the law, the board probably will not approve more than two or three of the scores of petitions now on file or about to be filed, because of the inflated bond issue market, the high cost of road building and other abnormal conditions.

New York Post Military Engineers Forms Permanent Organization

At a meeting held June 29, in the Army Building, 39 Whitehall St., New York City, a permanent organization of the New York post of the American Society of Military Engineers was formed. Preliminary organization had been effected two weeks prior to that meeting. Considerable interest is manifest in the formation of the New York post, both meetings being attended by approximately 100 former officers and enlisted men of the engineer establishment and officers of the Corps of Engineers.

In accepting the report of the organization and nominating committee the members of the New York post elected for the ensuing year the following officers: President, Col. F. A. Molitor; vice-president, Col. Geo. D. Snyder; secretary, Major P. E. Barbour; assistant secretary, Sergt. Allen E. Fitzgerald; treasurer, Major R. C. Coiner, Corps of Engineers, U. S. A. These officers, together with four directors-at-large, form the board of directors. The nominating committee presented seven names to ballot upon for directors-at-large, those elected being Col. R. D. Black, Major E. F. Robinson, Lieut. Col. A. S. Dwight, Col. Beverly Dunn.

A constitution at little variance with that of the parent organization was adopted. The formulation of by-laws governing the local society was by motion left to the board of directors, with the proviso that any changes in constitution or by-laws could be effected through a two-thirds vote of the membership.

The secretary read a communication from Major P. S. Bond, Corps of Engineers, U. S. A., in which it was stated that the membership cards in the parent organization had been received from the press and were now ready for distribution. Major Bond also reported through his letter the acceptance into the society of many new members.

The permanent organization of the New York post having been effected, its membership will now apply for a charter from the parent organization.

West Point Graduates Assigned To Engineer Corps

Those of the class recently graduated from the United States Military Academy who were assigned to the Corps of Engineers of the Army are: Francis E. Cox, Rhode Island; Thomas H. Stanley, Texas; Donald G. White, New Hampshire; Henry G. Lambert, Illinois; Charles G. Holle, Ohio; Charles S. Joslyn, U. S. Army; Arthur M. Andrews, Wisconsin; Edward C. Harwood, Massachusetts; John W. Moreland, Alabama; Wayne S. Moore, Illinois; Henry F. Hannis, West Virginia; Arthur L. McCullough, Wisconsin; Arthur V. L. James, Maryland; William W. Bessell, Jr., at large; James B. Cullum, Jr., at large.

Supplementary List of Delegates at Organizing Conference

In *Engineering News-Record* of June 10, p. 1138, was published a list of societies and delegates at the Organizing Conference held in Washington. D. C., June 3 and 4. Since the first list was compiled certain additions and corrections have been made. For the purposes of an accurate record, therefore, the following supplementary list is published:

Supplementary List of Organizations and Delegates in Attendance at Organizing Conference Washington, D. C., June 3-4, 1920. (*For Original List See Engineering News-Record, June 10, p. 1138.*)

American Association of Engineers,
A. B. McDaniel, Washington, D. C.
American Concrete Institute,
J. C. Pearson, Washington, D. C.
W. A. Slater, Washington, D. C.
American Society of Civil Engineers,
Richard L. Humphrey, Philadelphia, Pa.
American Society of Safety Engineers,
John A. Dickinson, Washington, D. C.
Associated Engineers of Spokane,
J. C. Stevens, Portland, Ore.
Connecticut Society of Civil Engineers,
T. A. Scott, Washington, D. C.
Engineers' Club of Columbus,
James R. Withrow, Columbus, Ohio.
Engineers' Club of Minneapolis,
O. H. Dickerson, Duluth, Minn.
Engineers' Club of Philadelphia,
Joseph A. Steinmetz, chairman, Philadelphia, Pa.
Richard L. Humphrey, Philadelphia, Pa.
Paul Spencer, Philadelphia, Pa.
Louisiana Engineering Society,
William B. Gregory, New Orleans, La.
Mining and Metallurgical Society of America,
F. G. Cottrell, Washington, D. C.
Minnesota Surveyors' and Engineers' Society,
O. H. Dickerson, Duluth, Minn.
National Safety Council—Engineering Division,
S. J. Williams, Chicago, Ill.
New England Water Works Association,
Leonard Metcalf, Boston, Mass.
Oregon Technical Council,
J. C. Stevens, Portland, Ore.
Society for Promotion of Engineering Education,
F. L. Bishop, Pittsburgh, Pa.
Society of Automotive Engineers,
G. W. Coggeshall, Washington, D. C.
Joseph A. Steinmetz, Philadelphia.
Society of Naval Architects and Marine Engineers,
W. H. Capps, Washington, D. C.
Homer L. Ferguson Newport News, Va.

Galveston Causeway Construction to Be Taken Over by County

On account of the rising costs of materials and labor the construction and repair of the Galveston causeway has been taken over by the Board of Managers of Galveston County under the provisions of the original contract, which has been held by Larkin & Sangster, Inc., Buffalo, N. Y. The contractors have notified the Board of Managers that the contract was forfeited as of date June 17, 1920. Under the contract entered into on Sept. 15, 1917, it was provided that if the total cost of the work should exceed $1,750,000 the county would take over the work. The contractors say this sum has been reached and that due to increasing costs of materials and labor and to increased cost of transportation it has been found impossible to complete the contract within the bid. Work will be continued under the direction of H. F. Jonas, who has been supervising engineer.

O. C. Merrill Named as Secretary of Federal Power Commission

Secretary of War Baker, who has been designated chairman of the newly created Federal Power Commission, has apointed Oscar C. Merrill, now chief engineer of the United States Forest Service, as executive secretary of the new commission at a salary of $5,000 per year.

Mr. Merrill was graduated from the Massachusetts Institute of Technology in 1905 and during his college course was connected with the city engineer's office of Augusta, Me. and the U. S. Geological Survey. After leaving college he taught for a while at the University of California and then was engaged on water-power surveys, sewer and sewage-disposal design and construction and water filteration projects in the Far West. In 1909 he became connected with the Forest Service and was assigned to the water-power investigations of that branch of the government. Since that time his major interest has been in Federal water-power administration and he has been one of the most important factors in the development of a Federal water-power policy. In his new capacity he will be the administrative head of the Government's water-power plans.

New Jersey Highway Commission Names Engineer

The newly appointed State Highway Commission of New Jersey was organized July 1. The new commission has named Thomas J. Wasser, county engineer of Hudson County, as state highway engineer to succeed William G. Thompson, resigned. George L. Burton of South River, was elected chairman of the commission and A. Lee Grover of Trenton, secretary.

Engineering Council Favors Single Quantity Estimate

The American Institute of Architects, Engineering Council and Associated General Contractors of America in October, 1919, appointed three conferees each, to discuss the matter of payment for estimating. These conferees agreed upon a report which was submitted to their respective organizations Feb. 17, 1920, and has since been under consideration by them. Engineering Council at its meeting, June 17, adopted the conclusion in a report of a special committee to which the report of the conferees had been referred, as follows:

"Whenever in the execution of work, competitive bids are asked for on detailed plans and specifications, those invited to bid should be provided with such an estimate of the quantities involved in the work as the surveys, plans and specifications permit to be made. The intent of this requirement is that a single estimate of quantities should be made by or for the engineer, architect, or other representative of the owner, so that each separate bidder will not be put to the expense of making up a separate schedule of estimates. This latter practice not only means a needless waste in the carrying on of contract work, but also discourages bidders and causes needless repeated handling of official plans and specifications in making up separate schedules of estimates."

Examination for Civilian Instructors, U. S. Naval Academy

An examination will be held in Isherwood Hall, U. S. Naval Academy, Annapolis, Md., at 9 a.m., Aug. 23, for the selection of two or more civilian instructors in the Department of Marine Engineering and Naval Construction. Candidates found qualified will be eligible, in the order of merit as determined by the board of examiners, for appointment to fill vacancies in that department, and others found qualified will be placed upon a reserve list. The annual salary of instructor in the department is $2,800. Candidates must be American citizens, and age limits are between 25 and 32 years, although the limits may be waived if candidates possess satisfactory courses.

The following qualifications will also be considered: Fitness to command the obedience and respect of students; degrees taken, post graduate work or other special studies; previous experience in teaching, and testimonials and references as to character and attainments. It is desired that applicants bring with them their references, which will be returned. Application must be filled out and returned to the Superintendent, U. S. Naval Academy, Annapolis, Md., without delay. The examination, which will be written, will require about three days.

A. A. E. Board of Directors Holds Quarterly Meeting

At the quarterly meeting of the board of directors of the American Association of Engineers, June 19, Dr. F. H. Newell, head of the department of civil engineering at the University of Illinois and past-president of the association, was appointed director of its field forces during the summer months. He will spend a large proportion of his time traveling and will assist the various chapters in solving their problems of organization and expansion. Dr. Newell was also elected a delegate to the Great Lakes-St. Lawrence-Tidewater Congress to be held in Detroit, July 22-24.

H. W. Clausen, general office manager of the C. D. Osborn Co., Chicago, was elected treasurer of the association, and the thanks of the association were ordered extended to John Ericson, retiring treasurer, for his useful services.

A motion was passed that each member of the Federated American Engineering Societies be invited to become a member of the association.

The board accepted the report of the building trustees, announcing that three types of buildings were under consideration; one type costing three million dollars, another one and a half million, and the third five hundred thousand, and recommending that subscription blanks be sent to members as a means of determining the amount of money which may be raised.

The national employment committee was instructed to formulate a person-

nel card and prepare plans for the expansion of employment service. The secretary was authorized to proceed also with the creation of an industrial department.

Ship Bursts British Dock Gates

With water level in the Alfred Dock at Birkenhead, opposite Liverpool, about 12 ft. above that in the Mersey River, on June 16 a small steamer in the entrance lock burst the gates open and plunged into the river. Several barges and small craft in the dock were carried out by the escaping water before the other gates of the lock could be closed. The steamer was not badly damaged, but barges were smashed and sunk and considerable quantities of coal and grain were lost. How the vessel got beyond control is not stated. A similar accident is reported to have occurred at the same place 22 years ago. At a still earlier date a coasting steamer approaching the entrance to one of the Liverpool docks from the river narrowly escaped striking the closed gates. In this case the indicator from the bridge to the engineroom broke down and the engine continued to turn ahead although the signal had been given to stop. The ship was steered so as to strike the masonry wall instead of the gate, the only damage being a slight denting of the bow.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Portland, Ore., Aug. 10-12.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

The Technical Club of Dallas (Tex.) has made application for membership in the Federated American Engineering Societies. The club voted unanimously at last week's meeting to take this action.

The Ohio State Engineers, at their convention held recently in Columbus, elected the following officers for the coming year: President, John H. Matse, Cincinnati; vice-president, W. L. Shawkey, Youngstown; secretary, George P. Kalsgye, Lakewood; treasurer, T. S. Garret, Dayton.

The Buffalo (N. Y.) Chapter, Society of American Military Engineers has organized a new body, the charter of which, it is explained, will be open to all engineers with military service records. The first meeting was held recently, at which Colonel Clarke S. Smith was elected president and Captain A. B. Jones secretary and treasurer. A series of monthly meetings is being arranged.

PERSONAL NOTES

CHARLES E. DONNELLY, assistant city engineer of Kansas City, Mo., has been appointed office engineer for the city planning commission.

ERNEST R. SPRINGER has been appointed chief engineer of the Boston Transit Department, succeeding Edmund S. Davis, who has retired after 47 years in the service of the city, as noted in these columns May 27.

W. T. LEE, of the topographic branch, U. S. Geological Survey, is engaged in making studies of the coastal plain of the Carolinas and the eastern shore of Maryland, from an aëroplane.

FRED J. LEWIS, of Bethlehem, Pa., has been appointed assistant professor of civil engineering at Lehigh University. Prof. Lewis was formerly with the department of streets and engineering of Springfield, Mass., as an assistant engineer.

C. C. WILLIAMS, head of the Department of Civil Engineering, University of Kansas, sailed June 28 for Europe, to study transportation problems.

H. N. RODENBAUGH has been appointed chief engineer of the Florida East Coast Railway Co., succeeding E. Ben Carter, retired under pension. Mr. Rodenbaugh's headquarters will be St. Augustine.

ARTHUR E. LODER, general inspector, U. S. Bureau of Public Roads, with headquarters at Washington, D. C., has been appointed district engineer with headquarters at Montgomery, Ala. He will have charge of the southeastern district, comprising the States of South Carolina, Georgia, Florida, Alabama, Mississippi and Tennessee.

J. Y. MCCLINTOCK, formerly superintendent of highways for Monroe County, N. Y., has become associated with George R. Newell, civil engineer, with offices in the Newell Block, Rochester, N. Y. The new firm will handle general engineering work, including studies, surveys and reports and preparation of contracts.

MAJOR H. L. MCMILLAN, formerly with the sewage disposal division, Bureau of Surveys, Philadelphia, has joined the engineering statff of the Sanitary District of Chicago as assistant engineer.

THOMAS L. WILKINSON has resigned as manager of operations of the Intermountain Railway, Light & Power Co., and opened an office as consulting engineer in the Boston Building, Denver, Col.

JAMES THOMSON, city engineer and architect of Dundee, Scotland, has been elected president of the Institution of Municipal and County Engineers, Great Britain. He is a native of Edinburgh, where he received his engineering education. He was appointed city architect of Dundee in 1904 and city engineer in 1906. Mr. Thomson was one of the founders of the Concrete Institute and is a member of the Town Planning Institute of Great Britain.

H. S. ROGERS has been appointed division engineer of the Susquehanna Division, Delaware & Hudson R.R., with headquarters at Oneonta, N. Y. He succeeds J. M. Silliman, resigned.

FRANK D. NASH, formerly chief engineer of the Missouri & North Arkansas R.R., has been made assistant valuation engineer of the St. Louis-San Francisco R.R., with headquarters at St. Louis.

W. F. TURNER has been appointed division engineer of the Tucson Division, Southern Pacific Co., with headquarters at Tucson, Ariz.

W. M. SCOTT has been appointed chief commissioner of the Greater Winnipeg Water District, succeeding R. D. Waugh.

A. U. M'AHON, state engineer of Montana, has resigned to become a member of the firm of the Western Construction Co., Helena, Mont. He is succeeded by C. S. Hidel, former assistant state engineer.

HARVEY DARTT, city manager of Mankato, Minn., has resigned to enter the employment of the Barrett Co., Minneapolis. Mr. Dartt was formerly city engineer of Owatonna, Minn. He will act as division engineer for the Barrett Co. in the promotion of Tarvia pavements.

SIDNEY D. STRONG has resigned as city engineer of Sault Ste Marie, Mich., to become city manager of Plymouth, Mich.

J. HERBERT FITHIAN, of Bridgeton, N. J., has been appointed supervisor of the New Jersey state highway system through Cumberland County, N. J., and parts of Salem and Gloucester Counties. Mr. Fithian is associated with Walter M. Sharp, engineer of Cumberland County.

JOHN S. SHERMAN, formerly with the Sanitation Corporation, has joined the sanitary engineering department of the Dorr Co., New York City.

P. M. BOWEN, who has been project engineer on Federal Aid road work, stationed at Roswell, N. M., has been appointed engineer of District No. 5, New Mexico State Highway Department.

J. WINTER SMITH, formerly engineer-appraiser for the Federal farm loan bureau, with the Montana Joint Stock Land Bank at Helena, has been engaged as irrigation engineer of the Montana Irrigation Commission.

ROY M. GREEN has resigned as professor of highway engineering at the Agricultural and Mechanical College of Texas to become president and

manager of the Western Laboratories at Lincoln, Neb. Western Laboratories will take over the consulting and testing practice of Clark E. Mickey, of Lincoln, and will specialize in the testing and inspection of all kinds of building materials and operations.

JEROME A. MOSS has resigned from the firm of Jos. E. Nelson & Sons, Chicago, and will engage in general railway contracting with offices in Chicago.

CAMPBELL SCOTT, WILLIAM D. ENNIS, GEORGE B. FRANKFORTER, ERNEST P. GOODRICH, CHARLES A. MARSHALL, FRED E. ROGERS, WALTER RAUTENSTRAUCH, FRANK B. MALTBY, ARTHUR W. HIXSON, and RUMSEY W. SCOTT, announce the organization of the Technical Advisory Corporation, 132 Nassau St., New York City, to act as consulting engineers and industrial economists and advisers. The officers of the new organization are: President, Campbell Scott; vice-president and treasurer, Ernest P. Goodrich, and vice-president and secretary, William D. Ennis.

JACK F. WITT, former engineer of Dallas County, Tex., has been named vice-president of the South-Central Division of the National Highway Traffic Association.

S. FRANK DOEBLER, construction engineer, Chicago, has gone to Austin, Tex., to take charge of the construction work on the Austin Dam across the Colorado River near that city. Work on the dam, which has been suspended since 1915, will be resumed at once.

OBITUARY

GEORGE W. VAUGHN, engineer maintenance of way, New York Central, exterior zone, lines east of Buffalo, with headquarters at New York City, died at Mount Vernon, N. Y., June 5, at 61 years of age. He was born at Paucutuck, Conn., and received his education in the Warner Polytechnic School, Providence, R. I. He began his career as rodman for the Pittsburgh, Cincinnati & St. Louis R.R., in 1881, subsequently serving as assistant to the engineer maintenance of way, supervisor of track, and assistant engineer maintenance of way, of that railroad. In 1887 he became assistant to the division engineer, Eastern Division, New York, Chicago & St. Louis R.R., later being promoted to division engineer and then to chief engineer in charge of property, reconstruction and maintenance of way. He entered the service of the New York Central & Hudson River R.R., in 1899, as supervisor of bridges and buildings, Eastern Division. The following year he was transferred to the Pennsylvania Division as division engineer and a year later to the Western Division. In 1905 he was appointed engineer maintenance of way.

JAMES M. EDWARDS, civil engineer and railroad operator, died at New York City, May 24, at 70 years of age. He was born in Oglethorpe County, Georgia, and graduated in civil engineering from the University of Georgia in 1869. Mr. Edwards was connected with the construction of the Louisville, New Orleans & Texas R.R., now the Yazoo & Mississippi Valley R.R., and was vice-president in charge of operations and general manager of that railroad until 1894. He was also connected with the Illinois Central R.R. In 1890 he moved to New York City, becoming associated with the R. T. Wilson Co., and had charge of the construction of the Yonkers street railway, of which he was president, and the Nashua electric line in Brooklyn. Later he re-organized and consolidated the street railways of Detroit into the present Detroit United Railways. Mr. Edwards was also president of the Matheison Alkali Works, Saltville, Va., and of its subsidiary, the Castner-Eltro Alkali Co., Niagara Falls.

BUSINESS NOTES

T. E. SPENCE has been appointed distict sales manager of the newly established New England office of the Reading Iron Co. located in the Compton Building, Boston. Previous to his connection with the above company, Mr. Spence for several years conducted a private engineering practice in Philadelphia, his clientele including a large group of industrial organizations. Later, he was associated with the Vacuum Oil Co., New York, in a special sales capacity, which position he resigned to join the sales staff of the Reading Iron Co.

THE BLAW-KNOX COMPANY, Pittsbugh, announces that the U. S. Senate has granted a petition to change the name of the town of Hoboken, Pa., where its plant is located, to "Blawnox." The company first established in Hoboken about five years ago, at the same time operating another plant at Wheatland, Pa. About two years ago the latter plant was removed and added to the Hoboken works. About 1,000 people are employed in the Blaw-Knox shops.

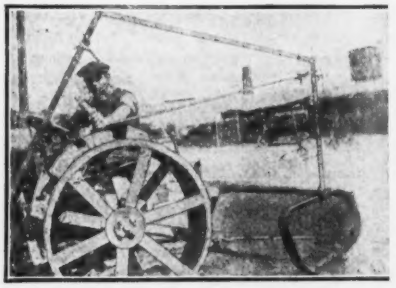
O. D. WEAVER, formerly with the Lidgerwood Manufacturing Co., is now associated with Robert B. Campbell Co., of Boston, New England agent for Ransome Concrete Machinery, Orr & Sembrow, Symons Clamp Co., and other manufacturers of contractors' equipment.

THE FREEMAN-RIFF CO. is completing its new plant at Terre Haute, Ind. This company manufactures conveying machinery, specializing in the design, manufacture and installation of installations for the handling of coal in boiler plants and retail coal pockets. J. B. Freeman, president, will be in direct charge of plant operation and production. Previous to his present position, Mr. Freeman was chief engineer of the De Pere Manufacturing Co., De Pere, Wis. D. M. Riff, secretary-treasurer, recently resigned from the American Steam Conveyor Corporation, as assistant manager of that concern's New York office.

THE PENNSYLVANIA PUMP & COMPRESSOR CO., Easton, Pa., has opened sales offices at 50 Church St., New York City; 2222 Chestnut St., Philadelphia; Fulton Building, Pittsburgh; Mutual Building, Richmond, Va.; Jefferson Bank Building, Birmingham; Newhouse Building, Salt Lake City, and First National Bank Building, Milwaukee.

Tractor Fresno Hitch and Control

A new mechanism, enabling the driver of a tractor to operate a fresno or grader attached to the tractor by means of a crescent shaped bar bolted solid at the center at the drawbar of the tractor, has been recently constructed, tested and is to be placed on the market. The points of the crescent extend outward and backward to clear the rear wheels of the tractor. The eye-bars of the fresno are shackled to the points of the crescent. This hitch brings the fresno close to the wheels, so the lateral swing on turns is reduced to a minimum.



TRACTOR-DRAWN FRESNO IS NEW GRADING DEVICE

The operation of the fresno is effected by a hand lever hinged to the body of the tractor, forward and below the seat. From there it passes upward and backward, where it is made convenient to the left hand of the tractor operator. To the upper end of this hand lever, just back of the operator, the front end of a "johnson" bar is connected and the rear of the "johnson" bar is connected to a bar attached firmly to the fresno. This attachment to the fresno is in line with the levers about 15 in. from the middle.

This new mechanism has been designed and built by O. S. Proctor of El Centro, Cal. Patents on the attachment and control are pending.